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REPORT

OF THE

Agricultural Research Institute and College, Pusa

(Including Report of the Imperial Cotton Specialist)

1910-11



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SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1912

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Report of the Agricultural Research Institute and College, Pusa,

(Including Report of the Imperial Cotton Specialist.)

1910-11.

REPORT OF THE DIRECTOR, AGRICULTURAL
RESEARCH INSTITUTE AND COLLEGE, PUSA,
FOR THE YEAR 1910-11.

(E. J. BUTLER, M.B., F.L.S.)

1. *Charge*.—I held charge of the office of Director, Agricultural Research Institute, and Principal of the Agricultural College, Pusa, throughout the year, in addition to my duties of Imperial Mycologist.

2. *Staff and work of the Institute*.—The Institute is organised in seven scientific sections, Agricultural, Chemical, Botanical, Mycological, Entomological, Second Entomological, and Bacteriological, the detailed reports of which are given in the body of this report. For much of the period under review, the superior staff was below strength. Towards its close, three supernumerary officers were absent on deputation or filling leave vacancies in the provinces; the Imperial Entomologist was on long leave; the Assistant Agriculturist's post was vacant; while I occupied the dual posts of Director and Imperial Mycologist. Thus, there were only eight European officers of the Pusa staff actually at work for the Imperial Department, and of these two (the Imperial Economic Botanist and his Personal Assistant) were engaged in Baluchistan, developing the

fruit industry of that province, in addition to their own duties.

The following summary gives very briefly the organisation of the staff, and the main lines of work of each section during the year.

3. *Agriculture*.—Mr. A. McKerral, Assistant Inspector General of Agriculture, was lent to take charge of the farm up to the 17th November, 1910, when Mr. G. Sherrard, Assistant Agriculturist, took over all except the work in connection with cattle and poultry breeding, which remained under Mr. McKerral until February, 1911. Mr. Sherrard held charge up to the 16th June, 1911, when he was appointed Professor of Agriculture, Bengal Agricultural College, Sabour, and Mr. A. C. Dobbs, Assistant Inspector General of Agriculture, was lent to take charge, pending permanent arrangements. Mr. H. Southern joined the staff as Supernumerary Agriculturist on the 29th November, 1910, but left again on the 13th February, 1911, to officiate for Mr. Sampson, Deputy Director of Agriculture, Southern Circle, Madras, who was about to proceed on leave.

Notwithstanding these frequent changes, and in spite of the fact that since February the farm has been managed by only a single officer, steady progress continues to be recorded. The *rabi* sowings were completed at an earlier date than any previous year, and the harvest was exceptionally good. A yield of 33 maunds of oats per acre was obtained from one field, and a record was established in thrashing, 241 maunds of oats being thrashed in one day with the steam thrasher. The rains set in early in June, 1911, and most of the *kharij* crops were sown before the end of the month and give excellent promise. Against this, the *kharij* of 1910 was marked by extensive floods in Behar, and a large part of the crops on the lower lands was lost owing to a breach in the protective embankment.

The experimental work on the farm suffered from the floods in the monsoon of 1910, one block of the permanent manurial and rotation experiments having been completely

destroyed. The duplicate block on higher land, however, escaped. It is too early to expect results from these experiments. The permanent pasture experiments were abandoned during the year, after full consideration of the results to date. It is evident that the improvement of pasture land will have to be attempted on different lines, and a modified plan of experiment is under consideration. A comprehensive series of manurial experiments with flax was started by the Fibre Expert to the Government of Eastern Bengal and Assam, in collaboration with the Inspector General of Agriculture, but an outbreak of dodder necessitated the destruction by burning of the whole crop. Flax dodder is not indigenous to India, and there is no doubt that every effort should be made to keep it out in future, and to destroy what was introduced in the past. Experiments with jute and paddy were continued, the former according to plans drawn up by the Fibre Expert. As the area under arable cultivation is now more than sufficient to provide fodder and grain for the breeding herd and work cattle, it is hoped to extend experimental work in the near future. A considerable part of the farm is devoted to crops grown for the other sections for observation and experiment.

The farm stock have done well. The Montgomery herd has been increased by natural growth and purchase. Proposals for a dairy were submitted during the year, but sanction has been withheld for the present. There is an undoubted demand for instruction in dairying, and with the large herd of excellent milch cattle now being formed at Pusa, a dairy will ultimately prove an essential part of the equipment of the Institute. The management of the poultry has been in the hands of the Inspector General of Agriculture for the greater part of the year.

I wish to record my appreciation of Mr. Sherrard's work not only on the farm, but in assisting me in the general management of the Estate.

4. *Chemistry*.—Dr. Leather held charge throughout the year. Mr. Annett, on the termination of his acting ap-

pointment as Agricultural Chemist, United Provinces, and on expiry of his privilege leave, resumed charge of his duties as Supernumerary Agricultural Chemist at Pusa on the 11th November, 1910. He has been since appointed to act as Principal of the Agricultural College, Cawnpore, and left Pusa to join this appointment on the 24th June, 1911.

The important investigation on the water requirements of crops in India, to which allusion has been made in previous reports, has advanced a stage, and a second memoir on the subject has been published by Dr. Leather. The principal conclusions arrived at are, that the nature of the soil has no effect on the transpiration ratio, but profoundly influences the rate at which water can move through the soil, and hence the total weight of crop produced. Also, that practically the whole of the water used by a crop is obtained within the root range, some 6 to 7 feet in alluvial soil, the large stores of water below this depth being substantially of no service to the plant.

Drain gauges to test the quantity and composition of the subsoil drainage water from arable land were erected some years ago at Cawnpore and Pusa, and the results of several years' records are now in the press. They yield information of the greatest interest on some of the factors which must always fundamentally influence Indian agriculture, when compared with that of temperate climates. Thus it has been found that the loss of water from bare fallow soil is almost constant year by year in any one place, and is at Pusa nearly double that at Rothamsted in England. At Cawnpore, on the other hand, it is little more than at Rothamsted, and this difference between Pusa and Cawnpore requires to be explained but probably depends on the nature of the soil. The protective influence against evaporation due to the presence of a crop has been approximately determined for different periods of the year. The amount of nitrate present in the drainage water from fallow land is very much greater than at Rothamsted, twice or three times as much, and nitrification occurs with

great vigour after the first heavy rain of the monsoon, but is not active during the dry months.

Dr. Leather has continued his investigation of *usar* land, with special reference to its physical state. He has also, in consultation with the Director of Agriculture, and the Irrigation Department, United Provinces, carried out the first stage of a comprehensive experiment directed to determine once for all whether, as is frequently stated, irrigation leads in certain lands to an increase of alkali.

Mr. Annett is engaged on a general investigation of the Date Palm sugar industry, a very important Indian industry, about which little accurate information is available.

An improved method of refining crude saltpetre was devised by Dr. Leather, and has been described in a Bulletin recently published. More nitrate is obtained than by the ordinary methods in use, the product is of higher quality, less fuel is required, and the process is independent of the weather. Its financial possibilities, however, remain to be demonstrated, and arrangements have been made to test the method on a commercial scale this year.

5. *Botany*.—Mr. Howard resumed charge of this section, on the expiry of privilege leave and deputation in England, on the 29th July, 1910. He was deputed to advise the Kashmir Durbar on hop cultivation from the 1st August to the 27th September, 1910. During his absence Maulvi Abdur Rahman Khan, Second Assistant, held charge of the current duties of the section. Mrs. Howard, who has ably assisted her husband during the past five years, was appointed Personal Assistant for three years from the 1st October, 1910. Mr. E. Holmes Smith, Supernumerary Economic Botanist, was on deputation in the Bombay Presidency throughout the year. He leaves the Department on the expiry of his agreement in October, 1911. Mr. Howard has been placed in charge of a scheme to develop the fruit industry of Baluchistan, in addition to his own duties, for a period of three years from the 1st May, 1911. He will work in Baluchistan for five months, from May to September, each year.

During his absence in England, Mr. Howard carried out some experiments in the production of rust resistant wheats suitable for India, and studied the trade requirements for improved Indian wheat and tobacco. He also enquired into modern methods of hop cultivation and drying and fruit packing, with a view to utilising the information on his return to India.

The possibilities of hop growing in Kashmir are apparent, when it is learnt that with a production per acre of one-fifth of that of Kent, an annual average profit of over £7 per acre has been realised on the Government hop garden, for the last sixteen years. In Mr. Howard's report to the Durbar, the directions are indicated in which improvements are possible, if it is decided to continue the industry on the present lines, and also the steps which are necessary if hop growing in Kashmir is to be placed on modern lines and if Kashmir is to enter the markets of the world as a competitor with California.

Perhaps the most important work on which Pusa is engaged at present is the improvement of Indian wheat. The lines on which this is being carried out have been sufficiently indicated in previous reports of the Botanical Section. The best Pusa wheats produced in 1910 were shown at Mark Lane, and on the Liverpool Corn Exchange, while Mr. Howard was in England, and were acknowledged to be without any superiors on the market at the time. During the past year, the high grain-quality of some of the best of these types has been combined with the high yield of low-quality Indian wheats, as a result of hybridization. The demand, both in India and abroad, for some of the improved wheats produced at Pusa has been far in excess of the supply. It is estimated that over 1,000 acres of the new wheats will be sown in Behar this year. At Raipur and Cawnpore, some of these wheats have proved equally successful, and extended trials have been arranged for at a number of other stations in the wheat-growing tracts of India. Mr. Howard is careful to point out that the full benefit of improved varieties can only be realised if cultiva-

tion is good and moisture is adequate. Disappointment is bound to result, if the influence of these two all-important factors in crop production in India is disregarded.

The improvement of tobacco is being carried on on similar lines to that of wheat. Both in yield and quality of leaf very encouraging results have been obtained.

The botanical study of certain fibres was continued, the isolation of the varieties of *san* (*Crotalaria juncea*) and *patwa* (*Hibiscus cannabinus*), and their improvement by selection and crossing, being the principal work in progress in this direction.

Further work on pollination in important crops of India was carried out, and a Memoir published giving the data for a number of crops.

Towards the end of the year, the lines of work on the improvement of the fruit industry of Baluchistan were developed, and the site of a new Experimental Station for the purpose selected near Quetta.

6. *Mycology*.—I held charge of this section during the year, in addition to the office of Director. Mr. Shaw continued to hold the post of Supernumerary Mycologist.

Much time was given to systematic work, as it was found that progress in Indian economic mycology was greatly hampered by the difficulty in determining the identity of the fungi of the country. All the specimens of one of the larger groups, the Ascomycetes, were worked through and annotated lists were published after the close of the year under review.

The charge of the campaign against palm disease in Godavari and Kistna Districts was taken over by the Madras Mycologist in 1910. It is being continued on the same general lines as before. A full account of the disease, and of the campaign against it carried on since 1907, was written by me and published as a Memoir in September, 1910. The conclusions arrived at are that the operations have been entirely successful in limiting the disease in Godavari to the area previously infected; the work in Kistna was started later, but the progress is encouraging

in this district also. The effect of the work in reducing the severity of the disease within the infected tract was not easy to estimate when the report was written, but with the further records since available it appears that a distinct decrease in the mortality is noticeable at the present time. If the disease can be effectively confined to the existing limits, the outlay incurred will be amply justified, and there is every reason to hope that the continuation of the work will lead to its being gradually stamped out altogether.

The need for a mycologist to work specially on the diseases of the tea plant has become increasingly apparent, and the Indian Tea Association have decided to add an appointment of this nature to their Scientific Department. Meanwhile, Pusa gives such assistance as is possible. Mr. McRae's Bulletin on blister-blight in Darjeeling, published at the beginning of the year, indicates the lines on which the control of this dangerous blight should be attempted. Many planters are experimenting on these lines, but the disease is firmly established and still spreading; unless a cheap and effective method of lessening its ravages can be worked out, there is every reason to fear that the result will be a permanent and considerable reduction of the Darjeeling tea crop. The copper-blight of tea was described by Mr. Shaw, the parasite which causes it not having been previously known to occur in India. A disease of tea seed was investigated by me, and shown to be probably associated with an insect which punctures the seed, and so admits rotting fungi to the tissues of the interior. It is believed that this insect can be fairly easily destroyed.

Other diseases investigated by the section, of which accounts were published during the year, were soft rot of ginger (by Mr. McRae), turmeric leaf spot (by myself), and heart rot of the blue pine (by Mr. Hafiz). Forest diseases, of which the last named is an instance, cause great losses in India; Pusa gives such assistance as it can to the Forest Department, but there is room for a mycologist to work specially at these diseases.

Mr. Shaw is engaged in investigating the root rot of a number of cultivated plants, caused by a species of *Rhizoctonia*. The parasite appears to be the same in all cases and its complete study, in view of the large range of its victims, is most desirable.

The usual routine work of advising cultivators and the general public interested in agriculture on the diseases of plants and allied matters, which in this section, as in the Entomological, forms a very essential part of the work, was continued. Assistance was also given to Provincial Agricultural Departments in advising on the work of their Mycological assistants, and in providing material for reference collections in their colleges.

7. *Entomology*.—Mr. Lefroy held charge of this section up to the 31st January, 1911, when he proceeded on leave, and Mr. T. Bainbrigge Fletcher, Supernumerary Entomologist, took over charge.

As in previous years, several provinces have freely availed of the assistance offered by Pusa in co-ordinating and checking the work of their Entomological assistants. Of these latter there are now seventeen, some engaged in teaching at the six Provincial Agricultural Colleges, the others in field work. The advisory function of the Entomological Section at Pusa is of great importance in the present position of Economic Entomology in India. The section helps by determining crop pests reported by Provincial assistants, and advises regarding the methods of control likely to be effective in checking them. In several provinces these methods have been demonstrated on a large scale, as in the work against potato moth and surface caterpillars in Bengal, cane grasshopper and potato moth in the United Provinces and several pests in Madras. In Baroda State also, the Entomological Assistant keeps in close touch with Pusa, and has shown much practical energy. In the same connection, mention should be made of the arrangements made directly by the section for demonstrating the life histories and characters of injurious and beneficial insects. A considerable exhibit was

arranged for the Allahabad Exhibition; show cases, coloured plates with brief descriptive leaflets, and coloured lantern slides, were issued for demonstration and distribution to those interested.

Sericulture continues to form an important branch of the work. Eri silk production has been developed as a cottage industry in many parts of India, and received a great stimulus through the display arranged at the Allahabad Exhibition, and smaller exhibits shown at local shows in Bengal. The industry has been taken up by the Agricultural Departments of Bengal and the United Provinces. Difficulty is still experienced in disposing of small parcels of cocoons and thread, the mills being unwilling to buy except in large quantities. Experiments in mulberry silk production have been extended. Crosses were effected between European univoltine and indigenous multivoltine races, with a view to obtaining a robust multivoltine race, yielding silk of better quality than is produced by native forms. Broods of European mulberry silk-worms were successfully reared at Pusa, the resulting thread being well reported on by the trade. Experimental work forms only a part of the activities of the sericultural branch; a great volume of correspondence has arisen in connection with it, and arrangements for the supply of disease-free eggs, castor seed, samples of cloth and machines for spinning, doubling and twisting have required much organising. Twenty students from various parts of India attended the special courses of practical instruction in silk culture during the year.

Lac culture was continued, and a practical training given to students in this subject. A large amount of material was collected, with a view to working out the races of lac insects in collaboration with Mr. Green of Ceylon, a specialist in the group.

Bees of two specially selected Italian strains were imported, and an attempt is being made to acclimatise them at Pusa. Apiculture is still, however, in the experimental stage.

The study of the life histories of injurious insects has progressed, a number of important pests having been reared in the insectary and their habits studied. Mr. Ghosh has prepared a memoir on palm beetles, and Mr. Dutt on some Aculeate Hymenoptera. Other memoirs on life histories are in preparation.

The insect survey of India has been continued as time permits. Large collections have been sent for study by specialists, and to the authors of volumes of the "Fauna of India" series. Mr. Nowrojee has prepared a memoir on some aquatic insects.

The investigation of the damage caused by termites (white-ants), started by Mr. Lefroy in collaboration with Mr. Evans, Deputy Director of Agriculture, Northern Circle, Central Provinces, was continued by Mr. Fletcher. The latter officer was also invited to tour with the Railway Sleeper Commission, to advise on the best methods of reducing the enormous losses caused on Indian railways by these insects, and is carrying out experiments on the preservation of wood from their attacks.

8. *Second Entomological Section.*—This section is engaged in the study of Dipterous insects, and in particular those which suck blood and which may transmit disease. Mr. Howlett, who is in charge of it, only rejoined after absence on sick leave for a year and five months, towards the end of March, 1911. The work of the section was therefore practically in abeyance until the last quarter of the year.

Since his return, Mr. Howlett has had to devote much time to disposing of collections of material accumulated in his absence. The identification of these has progressed with assistance from the Indian and British Museums.

As special work, Mr. Howlett has been engaged in a study of parasites of Tabanidæ ("horse-flies"); the temperature reactions of mosquitoes, temperature apparently being one of the main factors controlling mosquito bite; the relative efficiency of the fish known as "Millions" and other enemies of mosquito-larvæ; and peach flies. In the

latter investigation a method of destroying the male fly, which is simple, cheap and effective, has been discovered, and though it seems improbable that anything short of netting the trees will completely prevent the female reaching them, the destruction of the males should very much reduce the damage done.

While on leave, Mr. Howlett attended as Indian delegate the First International Congress of Entomology at Brussels, and read two papers by Mr. Lefroy and himself. He also carried out, in collaboration with two other gentlemen, a successful series of experiments on the range and rate of flight of house-flies under natural conditions, points of importance in view of their behaviour as carriers of disease. The results were published by the Local Government Board in England.

Since his return, Mr. Howlett has again given invaluable assistance in supervising much of the work of the artist staff, and in advising the other sections in the preparation of illustrations for publication.

In certain respects the work of this section differs widely from that of the other sections at Pusa. It was founded to study Diptera, not only those (comparatively few in number) which are serious crop pests, but also those which convey disease to man and animals. Mr. Howlett's work is, therefore, closely related to the work of the Medical and Veterinary Departments, and it is probable, taking into account the great developments towards a realization of the importance of biting flies as disease carriers, that the activities of the Second Entomological Section will expand in this direction rather than on more purely agricultural lines.

9. *Bacteriology*.—Mr. Hutchinson held charge of this section throughout the year.

Much of his work has been of preliminary nature, confined largely to trial and selection of the bacteriological methods best adapted for dealing with the special conditions of soil and climate in India. The main lines have been aimed at determining under what conditions various

soils will best serve as culture media for those bacteria, naturally present in them, on which the processes of conversion of the organic nitrogen of humus into assimilable nitrates depend.

A special study has been made of the effect of hot weather ploughing on the bacteriological content of the soil, and the possibility of a bacteriological explanation of the undoubted increase in fertility resulting therefrom. It was found that the net result is an extremely rapid formation of ammonia, part of which becomes available to plants and part of which is lost. Depletion of the soil nitrogen is a necessary consequence and the maintenance of fertility must depend on the restoration of this by green manuring or otherwise.

A bacterial disease of tobacco occurring in Rangpur was investigated by Mr. Hutchinson. It was found to be caused by a strain of *Bacillus solanacearum*, an organism known to cause disease in several cultivated crops, such as potato, brinjal and tomato. The Rangpur strain differs from those described in America and Japan in some of its pathogenic features.

A disease of the Eri silk-worm, which causes havoc in the broods at certain times of the year, was also studied. It was found to be associated with the presence of bacteria in the intestine.

Certain preparations known as Ratin and Trope Ratin, prepared in Copenhagen, have been widely recommended as rat exterminators, and have been suggested for use in India, both with a view to checking plague and to protect crops against the ravages of field rats. Mr. Hutchinson carried out tests of these preparations. Ratin was found to have lost its virulence, but it is suggested that this might be recovered by preparation in India. Trope Ratin was found effective within a limited time after its preparation, but its cost precludes any possibility of its use on a large scale by cultivators. Neither can be recommended for employment at present.

Agricultural Bacteriology in the wider sense, including the bacteriology of industries dependent on agriculture, has made great strides in recent years, and developments in the practical application of this branch of agricultural science in the tropics now appear probable, which were scarcely anticipated when this section was founded at Pusa. Proposals are being made for strengthening the section, which is understaffed.

10. *Training*.—Two different classes of instruction are provided at Pusa. Students are admitted for a post-graduate training in the scientific sections, being ordinarily required to take up a single subject only. Exceptionally, to meet definite requirements of Provincial Departments, which are not in a position to train their own men for such positions as Assistant Director, Farm Manager and the like, post-graduate students have been admitted to a general course, including a period of study in each of the chief sections as well as practical work on the farm. Ordinarily, however, it has been held by the Board of Agriculture that students requiring a practical agricultural training are best provided for by the six Provincial Colleges, and now that these are all in working order, it is not anticipated that there will be much further demand for the post-graduate general course. The second class of instruction given at Pusa consists of short courses of an essentially practical nature in special subjects such as silk and lac culture, cattle and poultry breeding and management, and fruit growing. To these it is hoped to add dairying, for which there is a decided demand which we are not yet in a position to meet, while the course in tillage implements and agricultural machinery was discontinued during the year, as it was not fulfilling any useful purpose. Instruction is imparted in English or in the vernacular, and no educational qualifications whatever are required.

Of the post-graduate students, one continued his course in general agriculture, and one in entomology left after having finished his course during the year. Six students were admitted, two in general agriculture, two in chemistry

and two in entomology. The two students in general agriculture were recalled to their province after completing one year's training, as their services were required by the Provincial Department.

The short courses continue to be popular, students from all parts of India having been admitted. Four took up fruit growing; eight, cattle breeding and management; nine, poultry breeding and management; three, tillage implements and agricultural machinery; twenty, sericulture; and fifteen, lac culture. A certain amount of instruction in bee-keeping was given to some students interested in the subject, but as apiculture at Pusa is still in the experimental stage, regular courses have not yet been established. As far as possible, only those have been admitted to the short courses who propose to take up the subjects taught as a subsidiary means of livelihood to agriculture. In some cases, it was found that non-agriculturists sought admission in order to obtain certificates which would get them employment under Government, especially in Native States. Usually such students were not admitted, or if admitted, certificates were not given to them.

11. *Upkeep of the Estate.*—As a result of the floods, to which the low-lying portions of the farm are subject, and which resulted in a loss of over 100 acres of crops in July, 1910, the Public Works Department was requested to revise the arrangements for draining this part of the Estate, and in particular to repair and strengthen the protective embankments were defective. The flood referred to was probably the highest on record, and gave us a very anxious time, but the bulk of the protective works stood very well, and amply justified the outlay which was incurred on them. The repairs have been deferred pending allotment of funds; fortunately there has been no flood up to date this year.

Two additional blocks of quarters have been constructed departmentally for the use of the staff of the Inspector General of Agriculture, in continuation of those built last year. A new workshop and weigh-bridge for coal were

constructed in connection with the power-house, and plans have been prepared for a coal bunker. The ice plant has been fitted up and is now under trial. It is capable of turning out half a ton of ice in the day. An ice store is being built departmentally. The laboratories consume a good deal of ice, which has formerly been obtained from Calcutta, and it is hoped that the new plant will not only prove a convenience but will effect an economy. Much trouble was experienced with the gas supply, owing to the retorts burning out. This culminated in a complete stoppage of gas for some weeks in the hot weather. The Oriental Gas Company of Calcutta kindly spared the services of their Chief Distributing Engineer, Mr. E. P. Reilly, to overhaul the installation. The laying of the retorts was found to be defective, and other minor alterations were carried out under Mr. Reilly's supervision, with the result that no further trouble has been experienced. We are under an obligation to the Company for their courtesy in sending up one of their best engineers to help us.

Provisional estimates for providing a Middle English School for the use of the staff of the Institute and the residents in the neighbourhood were sanctioned, the cost to be borne jointly by the Governments of India and Bengal. The estimates did not provide for residential quarters for the teachers; plans for the school and quarters were prepared with assistance from Mr. Preston, Inspector of Schools, Patna Division, and submitted with revised estimates for consideration by the Bengal Government. Some minor improvements were carried out in the students' hostel.

12. *Library.*—The revised catalogue of the library, corrected up to the end of 1908, was issued. The correction of the proofs and seeing it through the press entailed a great deal of work. The card catalogue was revised, and a register of new additions is now maintained in such a form that further editions of the printed catalogue can be brought out without much trouble. The loan arrangements are working admirably, and I am glad to note that

advantage is being more freely taken of the facilities for borrowing books given to officers of the Provincial Departments. The library is still wanting in many of the more expensive sets of periodicals; the sectional grants for purchase of books usually do not exceed 500 rupees; this is not more than sufficient for current literature, and there is no general grant from which expensive periodicals can be paid for. The new additions amounted to about 1,500 volumes. The library is rapidly becoming overcrowded and proposals for its extension are under consideration. The Director is in general charge of library arrangements and I wish to express my satisfaction with the work of Babu Anukul Chandra Chatterjee, the Librarian.

13. *Publications.*—The Journal, Memoirs and Bulletins were continued. As the Department expands, more work is submitted for publication, the Provincial Departments supplying an increasing volume of contributions. The grant for publications was reduced during the year, and transferred to the budget of the Inspector General of Agriculture. Much of the publication work is now done by the Inspector General, who is Editor-in-Chief, the Pusa staff supervising the illustration work and also acting as an advisory committee. The free distribution list was considerably curtailed during the year, consequent on the reduction of the grant.

14. *General Health of the Station.*—The general health of the station during the year under report was good. Relief was afforded to 7,657 new cases, of which 7,477 were treated in the outdoor department, and 180 admitted as indoor patients. This is an increase of 1,426 cases over last year's total. The increase in attendance was due to the great prevalence of malarial fevers, and cholera, in the surrounding villages. One hundred and forty-six cases amongst European officials and families were attended to, an increase of 47 over last year's total. The daily average number of patients treated was 7.87 indoor and 49.05 outdoor, as against 6.96 and 48.97 respectively during the previous 12 months.

Four deaths occurred in Hospital,—two from malarial cachexia, one from Bright's disease and one from neglected hernia.

Two cases of cholera occurred amongst the families of the Indian staff in August, 1910, with one death. Immediate and successful measures were taken to prevent the disease spreading on the Estate.

One hundred and one surgical operations were performed: of which eight were major and the remainder minor.

The prevailing diseases were malarial fevers, *kala azar*, bowel complaints, rheumatic complaints and skin diseases. Blood diseases were diagnosed microscopically.

Quinine was issued prophylactically on the Estate towards the close of the monsoon.

Fourteen primary and ten re-vaccinations were performed in the early part of the year.

All drains in the building area of the Estate were made pucca during the year. A small cemetery was constructed departmentally. The number of residents within the Estate was over 700 on the date of the recent census.

15. *Accounts*.—The total expenditure incurred during the current year was Rs. 2,99,587, as against Rs. 3,12,427 of the preceding year. The principal items of expenditure are pay of gazetted officers and establishment Rs. 1,87,383, travelling allowance of officers and establishment Rs. 22,315 and farm expenditure, scientific apparatus, books, fuel, stores for electric and gas installation, contingencies, etc., Rs. 89,889. The grant for the "Agricultural Periodicals and Journal" has been transferred from this office budget to that of the Inspector General of Agriculture in India from 1st April, 1910.

The gross receipts during the year by sale of farm produce, milk and other miscellaneous articles, and Mr. Lefroy's book "Indian Insect Life," amounted to Rs. 13,462, as against Rs. 5,573 in the preceding year. Of this amount the sale proceeds of "Indian Insect Life" accounted for Rs. 5,490.

16. *Visitors*.—During the year under report the Hon'ble Mr. E. D. MacLagan, C.S.I., I.C.S., Secretary to the Government of India, Revenue and Agriculture Department, the Hon'ble Mr. F. C. Gates, C.S.I., I.C.S., Financial Commissioner to the Government of Burma, Mr. R. Inouye, Assistant Professor, Agricultural College of Tokio Imperial University, Mons. H. Brenier of the Commerce and Industry Department of French Indo-China, and Dr. Vermoesen, Mycologist Elect to the Belgian Congo, visited the Institute. Dr. Vermoesen worked in the Mycological laboratory for over two months at the end of the year.

REPORT OF THE IMPERIAL AGRICULTURIST FOR THE YEAR 1910-11.

(A. C. DOBBS, B.A.)

Charge of the Pusa Farm during the greater part of the period under report was held by Mr. G. Sherrard, Assistant Agriculturist. The services of the Assistant Inspector General of Agriculture were also placed at the disposal of the Director for farm purposes, and in fact Mr. A. McKerral wrote the Annual Report for 1909-10.

In June 1911 Mr. Sherrard left Pusa to take up the appointment of Professor of Agriculture at the Bengal Agricultural College, Sabour.

Mr. H. Southern was at Pusa as Supernumerary Agriculturist from November 1910 to February 1911, when he left to go to Madras, where he is officiating as a Deputy Director of that Province.

Mr. Ikramuddin held the appointment of First Overseer and Mr. Ziauddin Hyder that of Second Overseer throughout the year.

Mr. Judah Hyam continued in charge of the breeding herd and Mr. Nizamuddin Hyder of the poultry. Mr. L. S. Joseph was appointed Veterinary Assistant in May 1911, and has taken charge of the current duties of the Overseer during Mr. Judah Hyam's absence on privilege leave.

Mahomed Yakub Mukadam of the Lyallpur Farm was appointed as Surveyor in May 1911.

The farm staff is to be congratulated on the thorough and timely preparation of the land for both the *rabi* and monsoon crops which is noted below, and the veterinary staff on the condition, and continued freedom from disease, of the breeding cattle.

Tours.—Mr. Sherrard visited the provincial farms at Dacca and Sabour in December.

Many members of the staff attended the Allahabad Exhibition in connection with the Pusa exhibits.

Training.—Mr. Fatchuddin, B.A., Assistant Director of Agriculture for the Punjab, continued his course in general agriculture during the whole period under report.

Babu B. L. Mukerji, B.Ag., and Babu B. B. Das, B.Ag., stipendiaries of Eastern Bengal and Assam, attended the course of general agriculture from July 1910 till March 1911, when they left to take up their duties at Dacca.

Mr. A. B. Hay-Webb worked on the farm as a visitor from 2nd to 27th March 1911.

The numbers of students attending the short courses have been :—

Cattle-breeding	8
Poultry Management	9
Tillage Implements and Agricultural Machinery	3*

Character of the Season.—The monsoon of 1910 was early. The rainfall was somewhat small (about 33"), but very well distributed and, in spite of the loss of the crops on large areas of low-lying ground owing to the river rising to a level higher than any previously recorded and owing to the breach of a bund that had previously protected the farm, the crops provided an amount of silage very much greater than the requirements of the cattle for one year. Over 4 inches of rain fell in October, thus ensuring an ample supply of moisture for the greater part of the *rabi* season, and as the sowings were completed at an earlier date than in any previous year since the establishment of the farm, these crops obtained an exceptionally favourable start, which enabled them to give a very good yield in spite of the fact that no further appreciable quantity of rain fell before harvest.

Rain also fell early in June 1911, and, owing again to the land having been thoroughly prepared beforehand, practically all the crops were sown before the end of the month and give excellent promise.

* This course has since been abolished as it has been found to serve no useful purpose.

Cropping.—The greater part of the farm was, as usual, devoted to growing fodder and grain for the working bullocks and the breeding herd. Maize, sorghum, oats, peas, khesari (*Lathyrus*), gram (*Cicer*) and arhar (*Cajanus*) were the principal crops grown for these purposes.

The maize provided a large quantity of excellent silage; that from the sorghum was not so good, much of it being decayed, and the right stage at which to cut this crop for siloing under the conditions obtaining here has yet to be ascertained. The oats provided a large amount of excellent feed both of grain and straw. The area of pulses grown was not, however, sufficient to make purchases of this class of food unnecessary.

Much of the arhar was spoilt by the floods.

A considerable area was, as usual, sown with Sann hemp for green manure.

Guinea grass, growing on nearly 3 acres within the influence of the bamboo avenues, gave over 300 maunds per acre of green fodder, with only two irrigations in the dry season; lucerne, with constant irrigation, gave over 200 maunds per acre.

Other crops grown on a small scale were flax (which had to be destroyed because of the appearance of dodder) and paddy. Experiments with paddy were inconclusive, the difference between the yields of the plots not exceeding the margin attributable to error.

The projected growth of varieties of wheat in extension of the work done by the Imperial Economic Botanist was abandoned. A large number of crops were grown, on small plots, under observation and for experiments carried on by the scientific officers.

Soybeans, obtained from Nagpur, yielded nearly 7 maunds per acre, which is not sufficient to pay for the cultivation and for the occupation of the land for two seasons.

Permanent Manurial and Rotation Experiments.—These were continued in accordance with the original scheme and the result recorded for future reference.

Permanent Pasture.—The manurial experiments were abandoned this year. There seems to be no doubt whatever that the direction which the experiments on pasture here should take is that of ascertaining the extent to which systematic grazing and extensive surface cultivation, combined possibly with the sowing of quick-growing catch crops, will enable land that cannot be economically used except as pasture to be maintained in a reasonably productive and profitable condition. The upland pasture is now ploughed up every three years and replanted with *doob*, but the *doob* does not look well on close examination even in the first year after planting, and disappears rapidly during the second year. A small part of the ploughed land has been sown with Sann-hemp this year for ploughing in before planting the *doob*.

Thrashing.—A record was established in thrashing the oats this year, 241 maunds being thrashed in one day. The heavy yield of grain, amounting on one field to 33 maunds per acre, no doubt contributed to this result.

Clearing and Levelling.—A large kiln was cleared from the former brick-field and a road across this area laid out and part constructed.

Work-cattle.—The number of cattle in use has been increased by the breaking-in of young cattle, purchased, and supplied from the Montgomery herd. The Montgomery cattle are rather slow, but can pull heavy loads. Foot-and-mouth disease broke out among the working bullocks towards the end of the monsoon of 1910, but was checked and suppressed by prompt measures.

Breeding Herd.—The Montgomery herd has been maintained in excellent condition, and the numbers of cows and heifers increased during the year. Fifty-four cattle were sold and four transferred to the working cattle during the year.

Only three animals died—less than 2 per cent., which is a very small percentage considering that the greater number of the cattle are cows and young calves.

Sheep.—The Gorakhpur sheep have done well, and the cross between them and the Dumbha ram appears to be successful.

Poultry-breeding.—One or two of the varieties of poultry originally imported have proved failures, and others have been substituted for them. Indigenous varieties have been obtained and appear in some cases to be worth keeping. But the work cannot yet be said to be beyond the experimental stage. The distribution of eggs by post and rail has been discontinued, but a considerable number of fowls have been distributed to the provincial farms and sold to private persons.

Programme of work for 1911-12.—1. *Cropping.*—An endeavour will be made to bring the different areas of the farm under systematic rotations suited to each and to the requirements of the cattle. It is proposed to increase the proportion of leguminous crops, and, in view of the excess of fodder provided by the present cropping, to reintroduce revenue-producing crops such as wheat, oil-seeds and possibly tobacco, on a small scale.

2. *Pasture.*—It is proposed to try simple experiments on the effect of surface cultivation and the sowing of leguminous catch crops on pastures.

3. *Laying out.*—The clearing of the former brick-field will be continued when time can be spared. The systematic grading of the fields all over the estate towards the roads or drains, so as to prevent the accumulation of water in patches in the centre of the fields, will be kept particularly in view.

Steps will be taken to prevent erosion and “washing” during heavy rain in a few places where it now takes place.

4. *Breeding-herd.*—The improvement of the milking capacity of the Montgomery herd will continue to be the principal object in view.

5. *Sheep.*—The production of cross-bred sheep with a view to ascertaining the suitability of the Gorakhpur Dumbha cross for mutton production will be continued.

6. *Poultry*.—Further trial will be given to some of the breeds already imported, the requirements of the provincial farms will be kept in view, and indigenous breeds will be further studied. The number of different breeds will probably be considerably reduced.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST FOR THE YEAR 1910-11.

(J. WALTER LEATHER, PH.D., F.I.C.)

Charge of Section and Establishment.—The section was in charge of myself during the entire year.

Mr. H. E. Annett, Supernumerary Agricultural Chemist, acted as Agricultural Chemist, United Provinces, until 10th November 1910. He again went to Cawnpore on 24th June 1911 to act as Principal, Agricultural College.

The changes involved during the year have been as follows :—Babu Subodh Chandra Kar, M.A., the second assistant, died on 19th July 1910. Subodh Babu joined the establishment at Dehra Dun in 1902 as a volunteer assistant and gradually rose to the position of second assistant. He had shown unusual ability and would no doubt have risen to still higher office. His death was a very severe loss. Babu Jatindra Nath Mukerjee, B.A., B.Sc., the third assistant, has been appointed second assistant. Mr. Bhailal Motibhai Amin, B.A., who was promoted third assistant, has, during the year, been appointed on deputation as assistant in the laboratory of the Behar Indigo Planters' Association. Mr. K. S. Vishwanatham, B.A., was selected by the Imperial Bacteriologist as his second assistant. Babu Adhar Krishna Bose was selected by the Scientific Officer, Indian Tea Association, as his assistant. The latter changes, although occasioning loss to the establishment, must be considered in the light of a compliment to the section and fulfil one of its important functions. Other changes have been as follows :—Mr. G. K. Lele, L.A.G., Nagpur, was appointed a junior assistant in August 1910; Mr. D. K. Ambekar, M.A., had to resign his appointment in April on account of family reasons; Mr. R. C. Sohoni left at the end of his probationary period.

Meteorology.—In addition to the ordinary meteorological records, the record of evaporation, which was mentioned in the last annual report, is being maintained. A record of soil temperatures has also been commenced during the year and will yield information as to diurnal and seasonal variations of temperature. Self-recording hygrometer and barometer will also be set up. Most of the information provided by these records will become immediately useful in connection with one or other investigations at the Institute.

Drainage Data.—These are being continued, and the first several years' records together with those of the Cawnpore gauges have been written up for publication. Among the deductions which have been possible are the following:—(a) The amount of water draining away annually varies with the rainfall, it being large in wet years; but the amount which evaporates from bare fallow soil is almost constant for any one place. At Cawnpore about 18" of water thus evaporates per annum, at Pusa about 28"; the corresponding figure at Rothamsted is about 15". The explanation for the larger amount evaporating at Pusa than at Cawnpore probably lies chiefly in the nature of the soil, but this is a matter which remains to be demonstrated. (b) Drainage from cropped land is naturally affected by the extra factor—the crop—and the drainage data have yielded some very interesting information in regard to it. On the one hand a crop transpires large amounts of water; on the other its presence acts as a "shield" to the moisture of the surface soil preventing it, in a measure, from evaporating. Thus the crop introduces into the question two factors, which are mutually opposed to one another, and the amount of drainage occurring from cropped land will be greater or less according to the magnitude of their respective influences. The effect of good crops growing on the Pusa and Cawnpore gauges has been to reduce direct evaporation to two-thirds or one-half of what the soil would have suffered had no crop been present. How much this "protective" effect is, when converted into inches of water, naturally de-

pend on the season of the year. During the dry season the general loss from this cause is much less than during the monsoon; hence the "protection" provided by a "rabi" crop will be generally much less than that of a "rains" crop; the former may be 2" or 3", the latter 7" or 8" of water. (c) The amount of water which runs off the land during heavy rain is known to vary within wide limits, and although the gauges have yielded some information on the subject, it relates to only one soil maintained perfectly level. No very explicit deductions are therefore possible, but the general conclusion has been drawn that perhaps popular ideas have exaggerated its amount.

The Amount of Nitrate in Soils.—This subject is one which has long been considered of great importance, and the drainage water from the gauges, as also some field records, have added much to our knowledge of the subject in so far as India is concerned. The total amount annually formed in fallow land is very much greater—twice or three times—than at Rothamsted. Then another feature has appeared, namely, that nitrification is not active throughout the dry weather, that is in fallow land—not irrigated; absence of moisture in the surface soil during a part of this period might be a controlling factor, but it is not a complete explanation, because the sub-soil is always moist, and here nitrification is similarly restricted to the monsoon. Nor does the variation of temperature offer any better explanation. With the advent of the monsoon, however, nitrates form with astonishing rapidity, the occurrence being most marked immediately after the first heavy rain. This investigation promises to prove of great interest.

The Water Requirements of Crops.—Allusion has been made in previous reports to this subject, and a second memoir, No. 10, Chemical Series, has been published. In continuation of what was published in Memoir No. 8, it has been found that the nature of the soil has no effect on the Transpiration Ratio; at the same time this factor has a great influence on the rate of water movement, and hence indirectly on the weight of crop produced. Field experi-

ments over several years have shown that practically the whole of the water assimilated by a crop is obtained within the root range, some 6 to 7 ft. in alluvial soil, and that although the stores of water present below this depth are very great, they are substantially of no service to the plant. The field experiments were at the same time utilised to check the values of the Transpiration Ratios which had been found by pot-culture methods. The two methods yielded very similar values for this factor.

The investigation into the *availability of plant food* in soils is being continued, but many difficulties have been met with, and its progress is slow.

Usar Land.—Reference was made to this subject in the last report, and the work has been extended. The first investigation had to do with a certain stretch of land in the Mainpuri District, and a very exhaustive series of tests showed that this class of usar land not only contains sodium carbonate, but is also highly impervious to water. The amount of movement of water, whether in the downward direction during wet weather, or towards the surface during the dry period, is thus necessarily only small; consequently also there cannot be any large amount of movement of salts.

Experiments made at Pusa on this soil have shown that by the application of common salt its physical state can be altered and the salts washed out. Rice was grown on some of it last year and is now growing again, but the method is, I fear, not financially feasible. In other experiments also made by pot-culture at Pusa, the physical defect (imperviousness) was separated from the chemical defect (alkali salts) and then plants sown. It was then found that of the two the alkali was the more pernicious.

During the past cold weather the investigation has been continued in another direction in collaboration with the Irrigation Department. One of the features of this alkali land is frequently the occurrence of "alkali spots" in the middle of fields otherwise quite fertile. It has been frequently argued that these result from the presence of

canals and excessive irrigation. The fact that the introduction of a canal is accompanied by a rise of the sub-soil water level has lent support to the argument. The two features are, however, distinct, and it certainly does not *necessarily* follow that they are related. We have some soil, taken from *fertile* land in the immediate neighbourhood of alkali spots under observation; it is maintained fallow with an artificial sub-soil water-supply at 2 ft. from the surface, and the experiment should show whether it will thereby become "alkali."

But the work of the past cold weather dealt with another aspect of this question. It is not only in canal-irrigated areas that "alkali spots" occur in cultivated fields; they are to be found in well-irrigated tracts also. It was decided, in consultation with the Director of Agriculture and the Superintending Engineer, to take samples from a series of such "alkali spots" situated (a) within a canal-irrigated tract, and (b) within a neighbouring well-irrigated tract, and to compare them by means of such methods as we at present possess. A suitable tract of country was found in the Muttra and Etah Districts. In the Sadabad (Muttra) and western part of Jalesar (Etah) parganas is a tract of country under well-irrigation, and alkali spots occur in many of the fields; thirty such alkali spots were sampled to a depth of 9 ft., excepting in cases where the kankar was too hard to drill through. In the eastern half of pargana Jalesar the irrigation is principally from the Etawah branch, Ganges canal, and in this tract twenty-nine alkali spots were similarly sampled to a depth of 9 ft. In each case a separate sample of every succeeding 6" was taken, and the whole of the specimens are now under examination. The first tract named is particularly suitable because although it has always depended on well-irrigation, the new Hathras branch of the Ganges canal is under construction, and the tract will hence shortly come under the influence of canal irrigation. All the fifty-nine alkali spots have been registered, mapped to show the approximate area, and the exact position of the boring, from which

the sample was taken in February, registered by means of distance and direction from a stone bench-mark especially put down on the field border. We shall thus not only have the results of the comparative tests of the present year, but it will be possible to form a very exact opinion at a future time, say ten or fifteen years hence, as to whether the introduction of canal irrigation has caused either an increase of the area of these "alkali spots" or any increase in the percentage of "alkali" in the soil. The tests of the soil of experimental plots near Aligarh which were referred to in last year's report showed that the only *really* effective means which had been tried was gypsum, and in that case the cost had been prohibitive. The land which Mr. Keven-ter has reclaimed was especially interesting. By the application of very large amounts of manure and liberal irrigation, crops have been grown for a number of years on some very bad alkali land. But the samples taken to a depth of 9 ft. showed that the result of the treatment had been to reclaim only the top foot of soil, and that below this layer, the soil is as bad as it was originally. The crops subsist in fact on the liberal manure supply of the top soil and can even then only succeed by the aid of frequent irrigation.

Date Palm.—Immediately after his return from Cawnpore, Mr. H. E. Annett took up, at my suggestion, the general investigation of the Date Palm Sugar industry. Hitherto nothing had been done in relation to the chemistry involved in this industry, and it is obviously desirable that this omission should be rectified. Mr. Annett toured twice in the Jessore District, which is one of the principal centres, and carried out a series of analyses of the juice on the spot and later on of raw sugar at Pusa, besides collecting much valuable information in regard to the methods which are employed. The work will be continued on Mr. Annett's return from Cawnpore.

Saltpetre.—During the year an attempt has been made to work out the practical details of an improved method of refining crude saltpetre which had occurred to me some

years ago as possibly feasible. The chief defects of the present methods are (i) the considerable time required in order to obtain the refined product, (ii) the amount of fuel used is greater than it should be, (iii) a serious loss of nitrate occurs, (iv) much of the refined saltpetre is of low quality, (v) the colour of the refined saltpetre is often brown instead of white, (vi) refining is often interrupted during the rains period.

After working on a laboratory scale, an apparatus was constructed which would deal with a maund of crude saltpetre per charge, and this was worked daily at the Allahabad Exhibition. It was in charge of Babu Jatindra Nath Mukerjee, who has carried out the whole of the experimental work connected with the process. The process is successful in largely eliminating the defects enumerated; nearly nine-tenths of the potassium nitrate in the crude saltpetre is obtained during the day as a white refined saltpetre of over 90 per cent. purity; no water has to be evaporated, and the process is independent of the weather. The other fraction of the potassium nitrate, which is not obtained by this process, remains in the muds and can be extracted by present methods.

The process created a great deal of interest among the refiners who visited the Exhibition, but there is naturally a considerable difference between entertaining an interest and actually replacing the present methods by a somewhat costly machine, and no definite opinion can be formed as to whether the new process will be adopted until it has been tried on a reasonably large scale, so as to form an accurate idea of the actual cost of working it. A proposal is at present under consideration to erect the plant at a refinery in Behar. A Bulletin has also been written on the subject.

Education.—There are two students from the United Provinces and Bengal, respectively, at present undergoing training, and another is to come from Travancore State. There are also two probationary assistants who have recently joined this section, who are in the position of students.

Programme of work for 1911-12.—1. The work on the availability of plant food in soils will be continued.

2. In relation to moisture requirements of crops, the current work has to do with the moisture conditions necessary to a green manure crop.

3. The investigation on Usar will be continued on the lines indicated in the body of this report.

4. The chemistry and manufacture of Date Palm Sugar will be investigated by the Supernumerary Agricultural Chemist.

5. Improvements in the refining of saltpetre will continue to be studied.

6. *Education.*—This requires no special comment and will be conducted according to the lines laid down.

Publications.—The following papers have been published :—

Memoir No. 10, "The Water Requirements of Crops in India—II," by Dr. J. Walter Leather, June 1911.

Bulletin No. 24, "The Indian Saltpetre Industry," by Dr. J. Walter Leather and Babu Jatindra Nath Mukerji, August 1911.

"Sugar-cane in India," published in the Agricultural Journal of India, Vol. VI, Part III, by Dr. J. Walter Leather.

"Chapter on Industrial and Agricultural Chemistry" for the Report of Board of Scientific Advice, by Mr. D. Hooper and Dr. J. Walter Leather, 1909-10.

"The Loss of Water from Soils during Dry Weather." Report of the Seventh International Congress of Applied Chemistry, by Dr. J. Walter Leather, 1911.

"The Transpiration of Water by Plants in the Tropics." Report of the Seventh International Congress of Applied Chemistry, by Dr. J. Walter Leather, 1911.

"The Effect of Manure on the Composition of the Grain of Field Crops." Report of the Seventh International Congress of Applied Chemistry, by Dr. J. Walter Leather, 1911.

REPORT OF THE IMPERIAL ECONOMIC BOTANIST FOR THE YEAR 1910-11.

(A. HOWARD, M.A., A.R.C.S., F.L.S.)

Part I.

Teaching, Training and Staff.

Charge.—I held charge of the section during the year under review except for the first 28 days of July when I was on privilege leave and on special duty in England.

Up to the end of July Maulvi Abdur Rahman Khan, Second Assistant, was in charge of the section. During my deputation to the Kashmir State in August and September 1910, he was also in charge of the current work at Pusa. In consequence of the satisfactory manner in which this assistant carried out his duties during five months in my absence in 1910, his services were rewarded by the grant of a special charge allowance for the whole period in question.

Students.—Four short course students attended the section during the year. Three of these worked well, especially the two sent from the Lushai Hills by Major Cole.

Staff.—In addition to the work done by my second assistant, Maulvi Abdur Rahman Khan, during my absence from Pusa in 1910, which has already been referred to, I have pleasure in recording the promising work of this assistant in Economic Botany. The third assistant, Munshi Ijaz Husain, who was in charge of current duties at Pusa on two occasions for short periods, has also improved in his work and made himself useful in connection with the tobacco-curing experiments. The work of the rest of the staff was satisfactory.

Part II.

Special Work in England.

To enable me to complete the work referred to in this section my privilege leave was extended by 17 days to a

period of three months. During this time the work done was the following :—

Wheat.—One of the directions in which the improvement of Indian wheat has been attempted at Pusa has been the increase in rust-resisting power of the kinds at present in cultivation in the plains. This is a subject which has on several previous occasions occupied the attention of the Government of India, but little or no results of practical value have been obtained in the past. It was found at Pusa and at Lyallpur that although the types at present in cultivation differ considerably in rust-resisting power, and that in consequence a considerable improvement in this character is possible by simple isolation methods, nevertheless India does not possess any wheats with the same power of withstanding rust as is shown by many of the wheats of Northern Europe, and especially by American Club. The quality of resistance of the best Indian wheats is of quite a lower order than that possessed by the wheats grown under the more adverse climatic conditions of the North Temperate Zone. This is seen not only when the two classes are grown side by side in India, but also when they are cultivated together in England. One of the directions, therefore, in which improvement might be attempted was, in the light of the work already done at Cambridge on the inheritance of rust resistance in wheat, the production of new kinds by hybridization between Indian wheats and some rust-resistant forms from Northern Europe or America. Attempts to carry this out in practice at Pusa failed on account of the impossibility of getting the rust-resisting parents to flower in time for crossing to be done and for the resulting grain to ripen before the hot weather set in. This difficulty was overcome by sending the Indian parents to Cambridge for spring sowing in 1910 and by carrying out the actual hybridization work in England. Thanks to the facilities given by Professor Biffen at Cambridge, crosses were made by us between various Indian types and American Club and other rust-resistant wheats at Cambridge, and the first generation of the hybrids was

grown at Pusa during the past wheat season. A duplicate set of these seeds was also successfully grown for us at the Cawnpore Experiment Station by Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces. Now that the difficulty of growing the first generation in India has been overcome, it is expected that among the progeny of these crosses wheats will be isolated of much greater rust-resistance than any of the types now grown in India. The work will be pushed on as rapidly as possible, and it is hoped before very long to have the results on a field scale.

Advantage was taken of my visit to England to consult with Mr. A. E. Humphries, Past President of the Incorporated National Association of British and Irish Millers, on many matters connected with the milling and baking qualities of Indian wheat and to go over in detail the samples sent to England for testing in 1910. I obtained a large amount of valuable technical information on the quality of wheat and also took full opportunity of discussing in detail the lines of future work on the improvement of Indian wheat. I consider Pusa has been exceedingly fortunate in securing for the milling and baking tests not only the invaluable assistance of an authority of the standing of Mr. Humphries in the wheat trade, but also his active interest in the work of improving the crop in India. I consider it will be far better in every way to continue to have the final tests of Indian wheats done in England than to attempt to carry out the work at Pusa under laboratory conditions. Results obtained under such circumstances in India will never carry the same weight as the opinion of the best available expert in the milling and baking trade.

In order to compare the appearance of the new Pusa wheats with those now on the market from various parts of the world, I visited Mark Lane with Mr. Humphries and the Liverpool Corn Exchange with Mr. Broomhall, the proprietor of the *Corn-Trade News and Milling*. It was acknowledged that there were no wheats on the market superior in combined appearance, quality and condition to

the best Pusa wheats. As far as quality only is concerned, Indian wheats are somewhat inferior to Manitobas, but in their greater dryness and in the greater thinness of the skin our best Pusa wheats at least make up for their slight lack of quality. As wheats are sold entirely on the appearance of the samples taken from the ships, it is of the greatest importance to the Indian wheat trade to keep the various grades of Indian wheats separate and not to mix red and white, hard and soft wheats in the same sample. This lowers the price that would otherwise be obtained, while adulteration with earth and other seeds does still greater harm. I saw several good samples of Indian hard white wheat at Mark Lane entirely spoiled by admixture with soft white and red wheat and with dirt and other seeds. A great work remains to be done in teaching the Indian cultivator the great importance of quality, uniformity and appearance in the wheat grown for sale in Europe. In Liverpool, the Pusa wheats were greatly admired and were shown to a meeting of Liverpool millers by Mr. Broomhall, who, in returning the samples to me in London, wrote: "I have just sent you back the samples you left with me. I have shown them to several of our millers who have greatly admired them. The wheat appears equal in value to the best Manitoba." (Letter dated July 8th, 1910.)

While at Liverpool the opportunity was taken of visiting the large new Grain Elevator recently erected by the Liverpool Grain Storage and Transit Company, which embodies all the latest American and Canadian improvements in construction.

Tobacco.—In connection with the work in progress at Pusa on the improvement of Indian tobacco, arrangements were made with one of the Directors of the Imperial Tobacco Company in London to visit two of the best factories in London to see the types of leaf made use of in England. These visits were of the greatest use, and some of the information obtained was applied in the tobacco-curing experiments at Pusa during the past year.

Hops.—In anticipation of my deputation to Kashmir to advise the Durbar on the improvement of the hop industry in that State, three visits were paid to Kent to see the latest forms of hop-drying oasts and the developments which have taken place in hop growing during the last five years. The information obtained was made use of in my subsequent visit to Kashmir.

Fruit packing.—In connection with the proposals for developing the fruit industry of Baluchistan then under the consideration of the Secretary of State, some time was devoted to studying the methods of packing and transporting fresh fruit both in use in England and also employed by the various countries which export fruit to London. Very valuable information was obtained which will be of considerable use in working out the best methods of sending fresh fruit from Baluchistan to India. By a fortunate circumstance I got in touch with one of the Directors of the largest company in Great Britain engaged in the manufacture of fruit packages on the American system, and in consequence have had no difficulty in importing into Baluchistan a large selection of model packages and packing materials for use in the experiments of the present year.

A study of the methods of packing used for transporting fruit from France, the Channel Islands and South Africa to London shows how backward India is in this respect and what great improvements are necessary in this country.

Part III.

The Hop Industry in Kashmir.

In accordance with the orders of the Government of India the months of August and September 1910 were spent on deputation in Kashmir for the purpose of advising the Durbar as to the best means of extending and improving the hop industry. A detailed report on this subject was submitted, which was afterwards printed by the State.

At present hop growing in Kashmir is in a very primitive condition, the average yield of sun-dried hops being less than $2\frac{1}{2}$ cwt. to the acre, or one-fifth the average yield of Kent. In spite of this, however, the net profits are very great, and for the last sixteen years have averaged about 130 per cent. or over £7 an acre.

The natural advantages possessed by Kashmir as a possible competitor in the world's hop production are considerable. Labour is cheap, plentiful, easily trained and easily managed. The soil of considerable areas of the valley is suitable for hops, while irrigation water is abundant, should it be found necessary to supplement the rainfall. Insect and fungoid pests are almost entirely absent, while the cost of transport to India is likely to be much cheaper as soon as the rope railway to Jammu is completed. These advantages, however, are not likely to be utilised to the full unless the Durbar decides to take the necessary steps to place the industry on modern lines.

In the details of cultivation, irrigation, training, picking and drying there is great room for improvement, and it was a great surprise to me to find that even a crop of $2\frac{1}{2}$ cwt. of saleable hops could be produced under present conditions. The cultivation of the crop is exceedingly defective, and a large amount of moisture is lost by the dense growth of grass and weeds and the absence of a surface mulch. This necessitates surface irrigation and the consequent hardening of the land and loss of tilth. Beyond the provision of single poles there are no attempts at training, so that there is insufficient space for the free development of bine and hops. The drying is done on sheets in the sun, and during this process the hops are a good deal broken, and a large amount of lupulin is lost.

In my report an attempt was made not only to present the scientific principles which underlie modern hop production, but also to indicate the improvements which are possible if it is decided to continue the industry on the present lines. In addition the steps were indicated that would be necessary if hop growing in Kashmir is to be placed on

modern lines and if Kashmir is to enter the markets of the world as a competitor with California.

In addition to the work on hops two other matters were dealt with in Kashmir at the request of the Revenue Minister. The first was an investigation into the wine industry, which is carried on by the State near Srinagar, and the second related to a general scheme for the improvement of the agricultural and horticultural industries of the State. In the case of wine industry, I recommended that this should be given up and the past expenditure in this direction regarded as a bad debt. As regards the development of the agricultural industries of the State, I drew up a detailed scheme in which many directions of improvement were indicated, and in which I recommended the amalgamation of the present agricultural and allied efforts of the State into one strong department under a competent European officer with the necessary experience. Time did not permit me to make all the necessary enquiries into a fourth subject on which my advice was asked for by the Revenue Minister and by the Minister for Education. This related to the introduction of Agricultural Education into the State, on which no useful suggestions could be made without first of all going into the present educational system as a whole.

Part IV.

The Development of the Fruit Industry of Baluchistan.

The proposals put forward by this section in 1909 for the development of the fruit industry of Baluchistan were, during the year under review, finally sanctioned by the Secretary of State, and work was commenced at Quetta in May of the present year. This extension of the work of the section has necessarily involved not only some re-organisation of the work at Pusa, but also an extension of the staff. The Pusa work both in training and investigation is now in great measure limited to *rabi* crops, thereby allowing the months May to September to be devoted to

fruit work in Baluchistan. The staff has been strengthened by the addition of a new appointment, that of Personal Assistant, which was given to a candidate who had worked in this section for nearly five years previously as a volunteer.

During the months May and June of the present year the lines of future work on the fruit industry of the Province have been worked out in detail, and a scheme has been put forward which has been accepted by the Local Government.

This falls into three parts. In the first place, a modern fruit experiment station will be started for the purpose both of demonstrating improved methods of producing and transporting fruit and also of affording facilities for further experiments likely to be of practical value to the country. One of the features of the new experiment station will be a nursery in which the best varieties will be propagated in large number for distribution to the zemindars. In the second place, a neglected fruit garden will be taken in hand, and methods of renovation will be commenced this year. Thirdly, steps are being taken to work out the most suitable methods of grading, packing and transporting fruit so as to make the most use of the present facilities for railway transport to India.

The country round Quetta has been explored, and a suitable site for the new experiment station has been selected, and steps have been taken by the local Government to acquire the land. The Honourable Colonel Ramsay, C.I.E., Agent to the Governor General in Baluchistan, who has strongly supported the scheme from the beginning, has placed a large fruit garden at my disposal for the renovation experiment. It is hoped that a beginning will be made with the packing experiments during the present year, and the necessary buildings for the fruit experiment station will be erected by September next.

In the preliminary work involved in the scheme I have been greatly assisted by the Political Officers stationed at Quetta. Mr. H. R. C. Dobbs, I.C.S., C.I.E., Officiating

Revenue and Judicial Commissioner in Baluchistan, has furthered the scheme in every way possible, while I am greatly indebted to Colonel McConaghey, Political Agent, Quetta-Pishin, and to Captain Keyes, Assistant Political Agent, Quetta, for the ready manner in which they have placed their wide knowledge of the country and of the people at my disposal.

Part V.

Investigations.

Wheat.—During the past year the Pusa wheat experiments have been extended in several directions, and results of great value have been obtained.

Seed Distribution.—A beginning was made during the year at several centres in the growth of Pusa wheats for seed distribution purposes. In Behar two planters volunteered to take up the work in 1910, and in both cases the yields obtained were far in excess of those obtained by the people with the local wheats. The seed thus obtained has been widely distributed to other planters, with the result that over 1,000 acres of the new wheats will be sown next October in Behar at a large number of centres. Over 100 maunds of surplus seed grown in the botanical area at Pusa was distributed last April in Behar alone, the demand greatly exceeding the supply. In the Central Provinces some of the early Pusa varieties were grown by Mr. Clouston, Deputy Director of Agriculture, at the Raipur Farm on a fairly large scale. Both in yield and quality these wheats proved superior to the large collection of other Indian wheats grown there. A further supply of other rapidly maturing wheats was accordingly sent to Raipur last April, and the best of these will be grown on a large scale by Mr. Clouston for distribution, mainly in the Chhattisgarh Division. Incidentally the wheat experiments at Raipur during the past season indicate that organic matter in the right condition is the limiting factor in wheat production in this tract. This matter is being taken up by

Mr. Clouston, and when the best method of enriching the soil by green manuring has been worked out I feel confident that wheat growing in this and similar tracts will at once be placed on a higher plane. In consequence of the satisfactory results obtained at Raipur, arrangements have been made with Mr. Evans at Hoshangabad for the trial of one of the earliest of Pusa wheats at that station. In the United Provinces the methods of cultivation of wheats which have proved successful at Pusa were tried on a large scale in the botanical area at Cawnpore by Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces. Both in yield and appearance of the grain the results obtained were very much better than those realised in the district. The Cawnpore results are particularly valuable, as they indicate the possibility of growing large yields of wheat of high quality under canal irrigation. At the Aligarh experiment station Dr. Parr, Deputy Director of Agriculture, United Provinces, obtained very high yields with one of the Pusa selections and has arranged for extended trials of this wheat in his circle during the next year. Arrangements for the trials of Pusa wheats next year have been made at Mirpurkhas in Sind and in the Punjab at Lyallpur and Gurdaspur.

A considerable demand for the new wheats has arisen from Australia in consequence of the satisfactory behaviour of the Indian samples grown there in 1909. In the same year a small sample of Pusa 6 was tried in Hungary with the result that 16 maunds of this variety were asked for by and supplied to the Minister of Agriculture of Austria-Hungary in April last.

One result of the wheat investigations, which is of considerable importance to India and to the future policy of the Agricultural Department, deserves special notice. This is the value of the variety of a crop when it stands alone. It is sometimes thought that in the case of crops improved varieties can be produced of such excellence that when distributed to cultivators greatly improved yields will result, no matter what the methods of cultivation adopted by the

people may be. A little consideration will show that these expectations are bound to result in disappointment as they entirely disregard the fact that two of the limiting factors in crop production in India are the methods of cultivation and moisture conservation adopted. Inadequate preparation for any crop and insufficient moisture cut across the real yielding power of varieties and tend to bring them to the same level. Optimum yields of the varieties and therefore true comparisons in yielding power are only possible if the limiting factors of bad cultivation and poor moisture conservation are removed. The full benefit of improved varieties, and especially those of high quality, can only be realised if cultivation is good and moisture is adequate. It is suggested that in all seed distribution schemes in India due attention should be paid to the prime importance of cultivation and moisture conservation as well as to the value of improved varieties. That it is possible to obtain greatly increased yields using only the means now possessed by the cultivators has been abundantly proved by the results obtained in the botanical area at Pusa during the last three years.

Trade Aspects.—Advantage was taken during the year of several opportunities of bringing the results of the wheat experiments to the notice both of the trade and of those interested in the cultivation of the crop. Everywhere the greatest surprise was expressed that wheats like those shown could be grown in India. In Karachi and Calcutta I ascertained from the leading wheat merchants that no difficulties are likely to be experienced by the growers in disposing (with considerable advantage to themselves) of uniform parcels of wheat of high quality. It is essential, however, that the quantities should be large and that the grades should be maintained from year to year. In Bombay a paper was read on the Pusa wheat experiments in the rooms of the Bombay Natural History Society, at which most of the wheat merchants attended, and at which an exhibit of the new wheats was shown. At the Allahabad Agricultural Conference I opened the discussion on wheat,

and as a result an extended trial of improved wheats and of improved methods of cultivation was arranged on some of the Court of Wards Estates. At the meeting of the Behar Planters' Association in February 1911 an account was given of the improved methods of wheat growing at Pusa which will be tried at a good many centres in Behar next year. Unfortunately, however, the demand for seed which arose after the meeting was far greater than the supply.

Milling and Baking Tests.—The most interesting point with regard to the milling and baking tests of Indian wheats during the past year is concerned with the quality of the new wheats raised at Pusa by hybridizing high yielding Indian wheats of poor quality (Muzaffernagar white and Punjab Type 9) with types of high grain quality but of lower yield. The results obtained show that the problem of combining high yield and high quality has been solved, the new wheats behaving in the mill and bakehouse like the high quality parent. A bulletin summing up the present position of this aspect of the subject and giving the results of 1910 in detail has been published. In response to numerous requests a full account of the actual methods adopted at Pusa in growing the crop has also been included. Translations in Urdu and Hindi of this paper have been prepared during the year by members of the staff.

Influence of the Environment on Quality.—The experiments on this subject which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, were greatly extended during the year, and a large number of samples have been forwarded to England for complete milling and baking tests. It is expected that the results will confirm the opinion previously expressed that high quality and high yield both depend on proper cultivation and on proper soil management previous to sowing time.

Tobacco.—A considerable amount of progress has been obtained during the year in the tobacco experiments.

Manuring.—It has been found at Pusa that the success of this crop in Behar depends on the rapidity of growth during October and November, and that this rapid growth is only possible provided a large supply of organic manure in the right condition is added to the soil. It is usual to use indigo *seeth*, oilcake and cattle manure for this purpose, but the application of these substances in sufficient quantity is a costly process. In 1909 it was found that green manuring with *san*, if carried out in good time so as to allow of a thorough incorporation with the soil, was not only as effective as the organic manures usually employed but also far cheaper. During the present year the results were repeated, and trials of the same varieties with *seeth*, *san*, cattle manure and oilcake were made. Both in yield and quality of cured leaf the results with *san* were entirely satisfactory, and accordingly the Pusa results have been brought to the notice of planters interested in tobacco growing in Behar, and extensive trials with *san* are now being made in the district. As in wheat growing it has been found at Pusa that attention to the details of cultivation and moisture conservation are of the greatest importance in tobacco cultivation. About 34 maunds of cured leaf (omitting the lower portions of the stalk usually included in Behar) were obtained to the acre at Pusa last year—a yield greatly in excess of the crops in the neighbourhood.

Curing.—Results of considerable promise have been obtained in the curing experiments which are being conducted in collaboration with the Peninsular Tobacco Company at Monghyr. The varieties used were both American, and also the most promising of the Pusa selections, and the method adopted was a modification of that usually employed by the people. Under the conditions of the experiment the Indian tobacco gave better results than the American, and one of the Pusa selections gave leaf of considerable promise. The experiments are being continued on a large scale.

Breeding.—Both in *Nicotiana tabacum* and in *Nicotiana rustica* considerable progress has been made by the

Personal Assistant in the investigation of the inheritance of characters in this crop which, as was expected, has turned out to be a somewhat complex subject. The object of this work is to discover the mode of inheritance of the various leaf characters in particular so that new and improved varieties can be made by hybridization. Practically nothing is known on this subject, and the scientific breeding of tobacco is still in its infancy.

Fibres.—*San* (*Crotalaria juncea*, L.).—Several new varieties of this crop have been isolated during the year, and interesting results have been obtained with this crop as a green manure. These are being repeated during the next cold weather at Pusa.

Patwa (*Hibiscus Cannabinus*, L.).—A paper on this crop in India is now about to appear in which the work done during the past four years at Pusa is summed up. Natural cross-fertilization takes place in this crop to a considerable extent, but it has been found possible to eliminate to a great extent the effects of this by removing the hybrids during the seedling and vegetative stages. Possibly these methods can be extended to other Indian crops in which crossing takes place and can be made use of on seed farms.

Pollination.—The importance of a close study of the methods of pollination in the crops of India and the bearing of these matters on the growth of seed for distribution to the cultivators in India were dealt with in a memoir published during the year. This matter was referred to in the previous annual report. The paper in question has attracted a good deal of attention, and the subject has been developed still further during the year. Natural cross-fertilization has been found to occur in *til* (*Sesamum indicum*), *rahar* (*Cajanus indicus*), *niger* (*Guizotia Abyssinica*) and in *Jute* (*Corchorus capsularis*). Some progress was made during the year in working out the pollination details in the various oil-seed crops grown in India.

Programme of work for 1911-12.—1. *Training.*—The training of advanced students in this section will be continued.

2. *Plant Breeding and Plant Improvement*.—During 1911-12 the following crops will be studied:—wheat, tobacco, oil-seeds and fibre plants.

(a) *Wheat*.—The botanical survey of the wheats of Baluchistan and the agricultural survey of the wheats of Bengal will be completed. The production of improved and rust-resistant varieties by selection and hybridization will be continued. The co-operative experiments on the influence of the environment on the milling and baking qualities of Indian wheats which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, will be continued on an extended basis.

(b) *Tobacco*.—The production of new varieties by selection and hybridization will be continued as well as the testing and curing of the varieties already isolated. The investigations on the influence of the environment on the stability of the type and quality will be continued.

(c) *Oil-seeds*.—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(d) *Fibres*.—The isolation and testing of pure races of the fibre plants of India will be continued.

(e) *Fruit*.—The fruit experiments at Pusa will be continued on the lines laid down in the First Fruit Report. During the months May to September, the work connected with the development of the fruit industry of Baluchistan will be commenced.

Publications.—The large amount of work that had to be got through during the past year has delayed the publication of results, but it is hoped this will be disposed of during the next year.

A fifth volume of *Die Züchtung der landwirtschaftlichen Kultur-Pflanzen* dealing with the breeding of tropical plants is now being published by Messrs. Paul Parey of Berlin under the editorship of Professor Dr. C. Fruwirth of Vienna. I accepted the invitation to contribute the articles on the following crops :—

Jute (*Corchorus capsularis* and *Corchorus olitorius*), til (*Sesamum indicum*), patwa (*Hibiscus cannabinus*), rozelle (*Hibiscus Sabdariffa*) and san (*Crotalaria juncea*). and papers on these have been forwarded to Vienna.

In addition the following papers have been published during the year :—

1. Suggestions for the Development of the Hop Industry of Kashmir. (Printed by the Kashmir State for official use.)
2. The Milling and Baking Qualities of Indian Wheats, No. 3. Some new Pusa Hybrids tested in 1910. Pusa Bulletin 22 (with G. L. C. Howard).
3. The Economic Significance of Natural Cross-fertilization in India. Memoirs of the Department of Agriculture of India (Botanical Series), Vol. III, No. 6 (with G. L. C. Howard and Abdur Rahman Khan).
4. Studies in Indian Fibre Plants, No. 2. On some new varieties of *Hibiscus cannabinus*, L., and *Hibiscus Sabdariffa*, L. Memoirs of the Department of Agriculture in India (Botanical Series), Vol. IV, No. 2 (with G. L. C. Howard).
5. Report on Economic Botany for the year ending June 30th. 1910. Printed in the Report of the Board of Scientific Advice, 1911.

REPORT OF THE IMPERIAL MYCOLOGIST FOR THE YEAR 1910-11.

(E. J. BUTLER, M.B., F.L.S.)

1. *Charge and Establishment.*—I remained in charge of the section throughout the year. Mr. F. J. F. Shaw held the post of Supernumerary Mycologist. Mr. J. F. Dastur was confirmed in his appointment as first assistant. Babu P. C. Kar was appointed to the vacant post of second clerk. All the staff have worked well.

2. *Training.*—Mr. F. Fateh-ud-din, Assistant Director of Agriculture, Punjab, attended for a mycological course once a week up to April 3rd. A forest ranger from the same province received a course of training in fruit diseases up to August 13th. A private student from Bombay abandoned the course early in the year. Amongst visitors Dr. Vermoesen, Mycologist elect to the Belgian Congo, worked in the Laboratory for over two months at the end of the year.

3. *Aid to Provincial Departments.*—Collections of named fungi, chiefly parasitic, have been supplied to the Madras and Mysore mycologists. A considerable number of specimens have been named for nearly all the provinces, the largest number being for Bombay and Eastern Bengal and Assam. Advice regarding the work of Provincial assistants has been given on several occasions.

4. *Plant disease investigations.* (a) *Palm diseases.*—A memoir giving a full account of the bud-rot of palmyra, coco and areca palms in Madras was published in September. An organised campaign, having as its object to prevent the spread of the disease and to stamp it out within the affected area in Godavari and Kistna Districts, has been in progress since 1907. The parasite (*Pythium palmivorum*) attacks the crown of the palm only, killing the tree by destroying the growing point. Spores capable of

spreading infection from tree to tree are liberated at an advanced stage of the disease. No other method of checking this infection was found practicable than burning the diseased tops before spores had time to form. This was carried out by gangs of toddy drawers recruited by a staff of subordinate officers of the Revenue Department under the control of a special Deputy Collector. Up to the end of the financial year 1910 about half a million palms had been cut out in Godavari at a cost of some Rs. 50,000. The operations were extended to Kistna in January, 1910. The conclusions given in the memoir are as follows:—"The operations have been entirely successful in limiting the disease in Godavari District to the area previously infected. Now that they have been extended into Kistna, it is fully trusted that they will be equally successful in checking the alarming spread to the south which has been going on for some time in that direction. This alone should fully justify the cost of the operations and their continuation. It is unfortunately impossible to estimate the number of trees saved from attack within the infected area. Still the number of trees saved in those parts where the work has been longest in progress must be many thousands, and apart from preventing any extension in the Godavari District, it is not unlikely that the value of the palms actually saved within the district already exceeds the cost of the operations." Since 1910 the control of the work has passed into the hands of the recently appointed Madras Mycologist, Mr. W. McRae.

(b) *Tea diseases*.—A bulletin by Mr. W. McRae, on the outbreak of blister blight of tea in Darjeeling District, was published in July. This contained a more complete account of the disease than the publications on the same subject mentioned in last year's report. It is unfortunately probable that the blight has come to stay in Darjeeling as it does not seem to have appreciably diminished since its first appearance. Many planters are experimenting on the lines suggested by Mr. McRae for its control, but it is evident that effective measures will be most difficult to carry

out. A tea parasite, *Laestadia Theae*, found in Java some 12 years ago but not previously recorded in India, was reported from the Dooars in July. It causes a leaf disease, known as copper-blight, which spreads with great rapidity, but appears to be closely dependent on weather conditions. A note describing its characters was written by Mr. F. J. F. Shaw for the January number of the Agricultural Journal of India. A disease of tea seed known for many years in Assam was investigated by the Imperial Mycologist in collaboration with the officers of the Scientific Department of the Indian Tea Association. It has been shown to be probably associated with the tea seed bug, *Poecilocoris latus*, which punctures the seed and sucks the juice. Through the opening thus made fungi are able to enter, and the subsequent injury to the seed is due to the growth of one or other of several species of rot-producing fungi at the expense of the seed tissues. The Tea Association is issuing a pamphlet pointing out that this insect is probably much more injurious in seed gardens than was previously suspected and recommending measures for its destruction. Several other tea diseases were investigated during the year, in particular the stem canker, the cause of which is still obscure.

(c) *Soft rot of ginger*.—Mr. W. McRae published an account of this disease in the Agricultural Journal of India, April, 1911. It is prevalent in Eastern Bengal, Gujarat, and probably elsewhere. In Rangpur the loss in damp soils is 10 to 15 per cent. of the crop; in bad years almost the whole may be lost. The cause appears to be the attack of a fungus (*Pythium gracile*) on the rhizomes and base of the plant. As a result of experiments carried out at Rangpur in 1908-09, Mr. McRae was in a position to recommend effective measures for checking the disease.

(d) *Turneric leaf-spot*.—This is a disease found all over Northern India, but not usually very destructive. It was found by the Imperial Mycologist to be caused by an undescribed species of *Taphrina*, and an account of it was published in the *Annales Mycologici* in February, 1911.

It is probably responsible for a reduction of the yield which may be much greater than the cultivators themselves suspect, but no treatment can be recommended as yet.

(e) *Wilt diseases*.—Experiments carried out at Pusa and independently by the Mycological Assistant of the Bombay Department at Poona, have demonstrated that the fungus which causes *rahar* (pigeon pea) wilt produces virulent spores on the stem of diseased plants. Hence it is advisable to pull out attacked plants early. Mr. Shaw has found that the cause of the death of cotton seedlings at Cawnpore is *Rhizoctonia* and not a *Fusarium* wilt. It is probable, however, that the cotton disease in the Central Provinces, Berars and other parts of India is a true wilt, and it is hoped to investigate this shortly. A gram disease resembling wilt, sent from the neighbourhood of Peshawar, was found to be caused by *Ascochyta Pisi* and not *Fusarium*. A supposed outbreak of indigo wilt which caused a good deal of alarm in September, was shown to be due to leaf-sucking insects.

(f) *Sugarcane diseases*.—The field experiments with red rot and *Cephalosporium* disease were abandoned as the plots became infected throughout, and were also attacked by white-ants. Successful inoculations were obtained with a fungus which causes a root disease in Madras and has not previously been described. The Bombay Department is following the recommendations of this section in introducing healthy sets into some districts where red-rot is severe.

(g) *Forest tree diseases*.—These continue to occupy a certain amount of time as there is no Mycologist attached to the Forest Department. The chief work of the year was the study by A. Hafiz Khan of the passage from root to root below ground of *Trametes Pini*, the fungus which causes heart rot of the blue pine. He published an account of his investigation in the *Indian Forester*, October, 1910. A serious disease of the *Nahor* (*Mesua ferrea*) has appeared in Sibsagar and Tista Divisions. It is undoubtedly caused by a fungus at the base of the tree, but we have

failed to isolate the species. A leaf disease of Piauhyensis rubber reported from Assam was identified as *Cercospora Cearae*, which has not previously been recorded on this tree. Diseases of sal, Casuarina, babul pods and deodar were also examined for the Forest Department.

(h) *Root-rot caused by Rhizoctonia*.—In September of last year a number of crops on the Farm were attacked by a species of *Rhizoctonia*. The crops damaged were principally groundnut, cowpea and jute, at the same time specimens of cotton seedlings from Cawnpore showed similar symptoms of disease. The fungus was isolated from each host and cross inoculations performed with a view to ascertaining whether special races of the fungus are restricted to particular hosts and the extent to which crops are liable to infection in the field. Owing to the subsequent discovery of *Rhizoctonia* on the mulberry and papaw, the scope of the work has since become extended; at present, except in the case of the *Rhizoctonia* on jute, the evidence is against the existence of special physiological races on particular hosts. A fruiting stage of the fungus was discovered on the groundnut and coincides with one which has been previously described as occurring on potatoes in America.

(i) *Other plant diseases*.—A disease of wheat which does not appear to resemble any hitherto described, was reported from Dharwar and Hoshangabad. It is hoped to investigate it more fully next season. The anthracnose of chillies caused by *Colletotrichum nigrum* was widespread last year, and we had several enquiries about it. Other anthracnoses examined were those of beans, sida, mango and plantain. An attack of a species of *Phytophthora* on rhea was reported from Dacca. The study of the *Phytophthora* on castor was continued. The downy mildew of *Cucurbitaceae*, *Plasmopara cubensis*, was found at Pusa during the year. This disease, which has been spreading gradually throughout the temperate portions of the world during the past fifteen years from centres in the United States and Japan, was not previously known in India.

The conidial stage of the *Sclerospora* on jowar was found in Bombay and supports the conclusion previously arrived at that the disease is identical with that of bajra due to *Sclerospora graminicola*. The number of parcels of specimens sent in for examination was 97, and, as usual, a large part of the routine work of the section was the identification of these; recommendations for the check of diseases caused by them were given when possible.

5. *Systematic work*.—Much time was given to this branch of the work during the year. It has been pointed out in previous reports that the accumulation of a good classified collection of Indian fungi is as necessary a part of the equipment of the section as the microscopes or other tools of the laboratory. In India, unlike more advanced countries, we have nowhere to turn to to get this work done for us. It is true that we have received generous help from specialists in other countries, but to secure this we have to undertake our share of the work. Within the past few years a large body of the *Phycomycetes*, rusts and smuts of India have been determined. The *Ascomycetes* were taken up last year, and some hundreds of specimens worked through and sent to Berlin, where the determinations will be published in collaboration with Messrs. H. and P. Sydow. Two large groups, the *Basidiomycetes* and *Deuteromycetes*, remain to be worked out, but it will not be possible to undertake their study for some years. Considerable additions to our knowledge of Indian *Phycomycetes* and rusts were also made during the year. Over 600 sheets were added to the herbarium.

6. *Miscellaneous*.—Mr. Shaw assisted the Imperial Bacteriologist in investigations of eri silkworm diseases and tobacco wilt. Eight show-cases of typical fungus diseases of plants were exhibited at the Allahabad Exhibition. A teaching collection of fungi with notes was prepared for the Elphinstone College, Bombay. A report was written on the invasion of *lantana*, a noxious weed of Mysore and Coorg, and measures for its check recommended. The

proposals made in collaboration with the Imperial Entomologist, for the legislative control of plant imports likely to introduce injurious insects and fungi into India, were printed and circulated for the consideration of Local Governments and public bodies interested, and have met with, on the whole, a favourable reception. To carry these proposals into effect will be one of the most important duties of the section in the near future. A note on the organisation of the service for the control of insect pests and fungus diseases was drawn up, also in collaboration with the Imperial Entomologist, for the International Institute of Agriculture, Rome. An outbreak of flax dodder at Pusa was dealt with, the crop being burnt. Recommendations were made to the Scientific Department of the Indian Tea Association of the best means to adopt for disinfecting tea seed intended for export, as this was insisted on in the country for which the seed was intended.

7. *Programme of work for 1911-12.*—(1) *Research and Experimental work.*—The work on the wilt diseases of crops will be continued on the lines indicated in the memoir on Pigeon-pea wilt published last year.

The investigation of the fungus diseases of sugarcane will be continued. The chief points of the present enquiry are the spread of red-rot through the soil, the relative immunity of thin canes to this disease, and the study of two undescribed cane diseases.

The study of some fruit diseases commenced last year will be continued, particularly with reference to their control by spraying.

The Supernumerary Mycologist is engaged on an investigation of the root-rot of a number of crops caused by the fungus *Rhizoctonia solani*. This will be continued.

(2) *Training.*—This will be continued on the lines indicated in the prospectus. Short courses will also be given to students taking the fruit growing and general courses and to private students, as during the past year.

(3) Advice regarding the fungus diseases of plants will continue to be given to other departments, particularly the

Provincial Departments of Agriculture and the Forest Department, and to the general public. The distribution of named specimens and other material to provincial colleges and other institutions will also be continued.

(4) The collection and identification of Indian parasitic fungi will be continued.

PUBLICATIONS.

The Bud-rot of Palms in India. E. J. Butler. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. III, No. 5, September, 1910.

A new genus of the Uredinaceae. E. J. Butler. Annales Mycologici, Vol. VIII, No. 4, 1910.

The Leaf Spot of Turmeric (*Taphrina maculans* n. sp.). E. J. Butler. Annales Mycologici, Vol. IX, No. 1, 1911.

Report on the Outbreak of Blister Blight on Tea in the Darjeeling District in 1908-09. W. McRae. Bulletin No. 18, Agricultural Research Institute, Pusa, July, 1910.

Soft-rot of Ginger in the Rangpur District, Eastern Bengal. W. McRae. Agricultural Journal of India, Vol. VI, No. 2, April, 1911.

Copper Blight of Tea. F. J. F. Shaw. Agricultural Journal of India, Vol. VI, No. 1, January, 1911.

Root Infection of *Trametes Pini*. A. Hafiz Khan. Indian Forester, October, 1910.

REPORT OF THE IMPERIAL ENTOMOLOGIST
FOR THE YEAR 1910-11.

(T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.)

Charge and Establishment.—Mr. Maxwell Lefroy, the Imperial Entomologist, held charge of the section until 30th January, when he proceeded on privilege leave and furlough out of India, the work of the section being then continued by me until the close of the period under review. There have been no changes in the permanent establishment during the year. Mr. C. S. Misra, the First Assistant, who was on privilege leave from the commencement of the year to 9th July 1910, had charge of the field-work on the Pusa Farm and Botanical Area and of the lac work, and has given two courses of instruction to students who attended for the short course in lac culture. Besides this, and apart from the personal instruction given by the Imperial Entomologist, Mr. Misra has had charge of the Laboratory and field training of the students in General Entomology; in this, as in his other work, he has done admirably. Mr. C. C. Ghosh, the Second Assistant, has been in charge of the insectary and has carried out extremely useful work in rearing and observation of insect pests. The Third Assistant, Mr. G. R. Dutt, has been in charge of the economic collections and records and has carried out the issue of coloured plates and lantern slides; in addition to his own heavy routine work, he has found time to study the Aculeate Hymenoptera and has prepared a Memoir on the life-history and habits of some of these insects. Mr. D. Nowrojee has been in charge of the general collections of insects and has done very good work in their upkeep and arrangement; this is work which naturally expands automatically every year, but Mr. Nowrojee has been able to do original work as well, and has written a Memoir on aquatic insects which is in the press at the date of this report.

He was away on privilege leave from 16th December 1910 to 6th January 1911. Mr. R. R. Ghose, who held the post of Sericulture Assistant, resigned on 25th October 1910, since when the position has been filled by Mr. M. N. De, who has worked hard and satisfactorily.

Visitors.—The Assistant Professor of Biology in the Punjab Government College, Lahore, and the Lecturer in Entomology at the Cawnpore Agricultural College, both worked in the Laboratory during their vacation periods, the former from December to January and the latter from March to June. The Entomological Assistant to the Baroda State spent a fortnight in Pusa discussing his work and his programme for the ensuing year and in collecting information likely to be of use. The Entomological Assistant, Burma, also spent about three months at Pusa, learning the practical side of Sericulture and obtaining information about crop-pests.

Training.—One student from the United Provinces remained from last year and continued his course in General Entomology until October. During the year, the newly-appointed Lecturer in Entomology at the Lyallpur Agricultural College and the Entomological Assistant in the North-West Frontier Province were received for the full course of training in Advanced Entomology, and will complete their course in December next. It is to be regretted that no students have been sent for the course commencing on 1st June 1911. The short courses in Sericulture were attended by many applicants from all parts of India, and of these thirteen have completed their course during the year; seven other students were received in June 1911, of whom six remain under instruction. The semi-annual short courses in Lac-culture have been taken up by fifteen students, of whom six were Forest Rangers specially deputed for this purpose. A certain amount of instruction in Bee-keeping has also been given to interested applicants, but as Apiculture in the Plains of India is still in an experimental stage, no regular course of instruction can be given before its success is assured.

Provincial Work.—The number of assistants employed in Entomological work in the Provincial Agricultural Departments is now seventeen, of whom six are engaged in teaching in the Agricultural Colleges and eleven in field-work, and of the above numbers two (one in each class) are still under training at Pusa. In view of the enormous areas to be dealt with and the general ignorance of the cultivating classes regarding insect pests and their control, this number appears very inadequate to place the practical side of Economic Entomology in its proper position as a normal part of agricultural practice, but the number of assistants is not being increased in the absence of Provincial Entomologists to direct their work. The fact that Economic Entomology forms part of the regular course in Agriculture at six of the Provincial Colleges must count for something in the spread of a knowledge of crop-pests amongst the agricultural classes. As in previous years, the assistance offered from Pusa in co-ordinating and checking the work of these assistants has been utilised by some provinces, who have referred the more technical work to Pusa, leaving the field-assistants free to undertake practical work and demonstrations.

In Madras, steady progress has been made in investigating the insect-pests of crops and in devising and demonstrating means of control applicable against each, and very good work has been done; this is the more important because the insect-pests of Madras are to a large extent different from those which occur in the plains of Northern India. In the Central Provinces, the experiments against Termites (white-ants) have been continued at Hoshangabad in collaboration with the Deputy Director of Agriculture, Northern Circle, and work against Potato Moth has also been continued. In the United Provinces, good work has been done in demonstration of methods against Cane Grasshopper and Potato Moth. In Bengal, very good work has been done in experiments and demonstration of methods of storing potatoes to keep them from Potato Moth, which is steadily spreading throughout the province. In Eastern

Bengal and Assam, the principal pests dealt with have been the Rice Grasshopper, Semiaquatic Rice Caterpillar and the Behar Hairy Caterpillar. In Baroda State, the Entomological Assistant has done good work in promoting an interest amongst cultivators in such pests as the Hairy Caterpillar, the Bollworm and the Til stem-borer and in inducing the adoption of measures against these and other pests.

Generally speaking, the Entomological work in the Provinces is at present preliminary and is necessarily confined to little more than inspection of the experimental farms, noting the local pests and the destruction caused by them and demonstrating methods to cultivators in the event of any special outbreak. Much more than this cannot be done whilst the Provincial Entomological staff is so limited.

Correspondence.—This is a subject which increases automatically every year as the work of this Department becomes more widely known. In addition to local inquiries as to insects attacking crops received and answered by the Provincial Agricultural Departments, a very large volume of correspondence is received and dealt with at Pusa; this includes a large amount of correspondence received from official sources, but a very large proportion is in reply to questions and requests for information and advice by the general public, and these include queries on almost every conceivable phase of Entomological work—insects damaging crops, gardens, orchards, timber, ornamental trees and shrubs, books and papers, stored cereals and produce of all kinds, insects on domestic animals, silk, lac, bee-keeping, insecticides and sprayers, and the identification of insects—and even on subjects not strictly concerned with insects, such as the destruction of rats. The parcels of injurious insects sent in numbered 166. A total of 2,384 inquiries came in from official and public sources, and the whole of these were dealt with as fully as possible. This is work which occupies a very large and constantly increasing proportion of time, but we consider that this work has a very direct value and that it is our duty to satisfy

every inquirer to the best of our ability. The large increase of clerical work during the year has thrown a great deal of additional work on the Clerk (S. C. Mukerji) and Typist (T. V. V. Subramani), both of whom have worked very satisfactorily and their work deserves special mention.

Research.—Progress has been made with inquiry into the life-histories and habits of injurious insects. Amongst the more important of these have been the Rhinoceros Beetle, the Surface and Painted Grasshoppers, Potato Bug, Lucerne *Hypera*, Small Cabbage Caterpillar, Termites, Rice Weevil, Green Bug, Potato Mealy Bug, Fish Insect and Red Pumpkin Beetle. Experiments have been made on the preservation of wood from attack by Termites (white-ants). Assistance has been afforded to the Imperial Agricultural Bacteriologist in furtherance of his work on the diseases of Eri Silkworms.

Insecticides and Sprayers.—A number of patent insecticides received for trial have been tested and reported on as to their suitability for Indian conditions; as a rule, they are not superior in efficacy to simple mixtures procurable locally, whilst their prices are prohibitive. Information on insecticides for Indian use has been collected in Bulletin No. 23. An increasing number of spraying machines is sold in India every year, and this Department keeps a register of the places where insecticides and spraying machines are obtainable, so that inquirers can be at once referred to the vendor supplying the kind suited to their needs.

Sericulture.—Experiments have been made on the crossing of Italian and French Univoltine Mulberry Silkworms with all the available indigenous multivoltine races, the object being to secure a robust and vigorous multivoltine race yielding a better silk than is produced by the native forms at present cultivated. Up to the present the mongrel races produced by crossing the European univoltine with Nistari and Burmese stock give the best promise as regards yield and quality of silk. Some of the

crosses between multivoltine indigenous races have also produced individuals more vigorous, more productive and less liable to disease than either parent stock. It will, however, require some time to establish a race which can be recommended.

Mulberry Silkworms from European seed were successfully reared at Pusa on bush mulberry in November 1910 and March 1911, the resulting thread having been valued by the trade in Calcutta at prices which compare extremely favourably with that obtainable from any multivoltine race. If it is possible to rear one (or, in many localities, two) broods of European worms on bush mulberry in Bengal and Eastern Bengal—and the Pusa experiments indicate no reason why this should not be done—the fact may have an important bearing on the silk trade.

The cultivation of Eri Silkworms has been continued at Pusa and is at present carried on in almost every district in India. The interest displayed in the cultivation of the Eri worm received a great stimulus through the display of Eri products at the Allahabad Exhibition, where a large building was entirely devoted to sericultural methods and manufactures collected and exhibited by this section. Here every process, from the egg to the finished cloth, was shown actually at work under practical conditions, and all kinds of silk cocoons, threads, cloths, etc., were also exhibited, a gold medal being awarded for these exhibits at the close of the Exhibition. An assistant from Pusa was in charge of the exhibits, and his time was fully occupied in explaining the processes and attending to innumerable inquiries from interested visitors, and particularly in bringing to their notice the advantages of Eri Silk and its cultivation in the provinces in localities where the climatic conditions and other factors are favourable to the adoption and extension of the industry. Batches of visitors—especially of the cultivating classes—were taken round and carefully shown the details of the work. A discussion was also held at the Agricultural Conference at Allahabad regarding the steps to be taken to extend the industry in the

United Provinces. Illustrated pamphlets, in English, Urdu and Hindi, describing the methods of rearing Eri and Mulberry worms, had been prepared at Pusa beforehand, and the real interest evoked by the exhibits could be gauged fairly accurately by the demand for these pamphlets and the large volume of further inquiries which has since come in to Pusa. Besides Allahabad, Mulberry and Eri worms, cocoons, thread, cloth, etc., and spinning and twisting machines in working order were shown at the local Agricultural Exhibitions at Muzafferpur, Bankipur, Malda, Banjetia, Singeswar and Calcutta.

Disease-free Eri and Mulberry silkworms' eggs, cocoons, thread, samples of Eri cloth, castor seed, mulberry cuttings and seed have been distributed to inquirers in all parts of India as far as possible. Trained rearers have also been sent to many places to teach Eri-culture to cultivators and others desirous of trying this product. Arrangements for sale of spinning machines have been continued, and at the request of the Imperial Entomologist, who pointed out what was required, a combined doubling and twisting machine, for doubling and twisting mulberry silk in one operation, was designed and produced by Mr. E. F. Watson and is now on sale. In extension of the work done here Eri silk-work was taken up by the Bengal Agricultural Department at Sabour from 1st April 1911, and it is hoped that the exhibition of this industry, within reach of the silk trade at Bhagalpur, will lead to the extension of the popularity and production of Eri Silk. Eri Silk has also been taken up by the Agricultural Department in the United Provinces, where Mr. Akhtar Mohammad Khan, Deputy Collector, has been deputed to conduct experiments at Shahjahanpur, and at Coimbatore by the Madras Agricultural Department. Successful attempts have been made to twist and dye Tussar Silk, but rearing of this has not been done at Pusa. In March 1911, at the request of the Director of Agriculture, I made a short tour in Eastern Bengal to investigate into the decline of the Mulberry silk trade and advise remedial measures; the result, which has

been reported already, cannot be summarized here. Eri thread of fine count has been produced on a commercial scale by the Chhoi Silk Mill Co. at Bombay, and the use of this fine thread should have an important influence on the development of the industry. There is still some difficulty in the disposal of small parcels of cocoons and thread by rearers on a small scale, the mills being unwilling to buy except in large quantities; a good deal of help in this direction has, however, been afforded by Calcutta firms who have been taking small parcels for shipment of the silk to Europe for experimental purposes.

Lac-culture.—Experimental work in lac-culture was continued, and brood-lac was supplied to applicants in Bengal, Central India, Madras and Bombay. Fifteen students were given a thorough practical training in lac-culture and numerous inquiries on this subject were also dealt with by correspondence. A continuation was made of the collection of material in collaboration with the Forest Department, with a view to the working out of the races of Lac Insects by Mr. E. Ernest Green, Ceylon Government Entomologist, 67 parcels containing 325 lots of specimens from a large number of food-plants having been received during the year. The material, as it accumulates, is sorted out with a view to facilitate the working out of the various races when the collection is completed.

Apiculture.—Two strains of specially selected Italian honey-bees were imported from England in November 1910, with a view to ascertaining their suitability to the conditions prevalent in the plains of India. The experiment has so far proved a success, but it is too early as yet to pronounce definitely on this.

Demonstration.—The most important item under this heading is probably the Allahabad Exhibition. Apart from the exhibits in the Silk House, 15 show-cases of insects injurious to crops and 24 cases showing the food of as many common Indian birds were prepared and exhibited in the Agricultural Court, 19 show-cases of Indian insects

were prepared for the Forestry Court, where this exhibit was awarded a gold medal, and, in the absence of the Second Imperial Entomologist, an exhibit of four show-cases was prepared for the Medical Court by the Supernumerary Entomologist to show the relations between insects and such diseases as Malaria, Enteric Fever, Plague, Myiasis, Cholera, Sandfly Fever, Yellow Fever, etc. I attended the Agricultural Conference held in January at the Allahabad Exhibition, and read a paper discussing practical remedies against two of the most destructive insects of the United Provinces.

Steady progress has been made in the preparation and issue of coloured plates illustrative of insect-pests of crops, and these have been distributed to all Provincial Agricultural Departments, to Museums, Agricultural Societies and numerous Educational Establishments. These plates are available for demonstration and for use in illustration of popular articles in vernacular and other Provincial journals. Show-cases were prepared and sent to the Dasehra Exhibition in Mysore. Coloured lantern slides of subjects selected from the coloured plates of crop-pests have been prepared and a large series of these is now available, besides series on Silk and Lac.

Insect Survey.—Comparatively very little time has been devoted to the general collections, but steady progress has been made, a large number of accessions having been added and arranged. Considerable additions have been made to the Students' Working Collections. Collections have been made up and sent out for identification by specialists and to authors of volumes in preparation for the *Fauna of India* Series; these include *Collembola*, *Orthoptera*, *Tettigidae*, *Termitidae*, *Neuroptera*, *Odonata*, *Braconidae*, and *Ichneumonidae* *Hymenoptera Aculeata*, *Dynastidae*, *Rutelidae* and *Cetoniidae*, *Curculionidae*, *Cleridae*, *Microlepidoptera*, *Thysanoptera* and *Rhynchota*. Collections have been identified for Provincial Assistants, the Indian Museum, the Bombay Natural History Society's Museum, the Quetta Museum and for many private collectors.

Miscellaneous.—Exhibits illustrating the work of the section were sent to the International Congress of Entomology held at Brussels in August 1910. Entomological inquiries and notes sent in to the Bombay Natural History Society have been dealt with and the Imperial Entomologist lectured to the Society on the eve of his departure from India. Requests from officials and private persons outside of India for information, specimens, etc., have been complied with as far as possible. Live Eri cocoons have been sent to England, France and Morocco.

Programme of work for 1911-12.—The work of the past in advising on insects will be continued, and concurrently the study of the insect-pests of crops will be carried out in the Insectary at Pusa and by the Provincial Assistants. Assistance will be given, when desired, in co-ordinating and directing the Entomological work in the Provinces, and special help will be given in the event of any serious outbreak. The issue of coloured plates and lantern slides will be continued. The experimental work with bees will be continued and extended if possible. Instruction in Eri and Mulberry silk-culture and in the cultivation of Lac will be given to students attending short courses in these subjects. Further collections will be made of lac insects in all stages for the purpose of ascertaining the relationships of the various races. New insecticides and apparatus submitted for trial will be tested with a view to their utility under Indian conditions. Rearing of Eri Silk-worms will be continued and all possible help given to those commencing this industry. Further experimental work will be done on the mongrelisation of the races of the Mulberry Silk-worm, and it is anticipated that the provision of cold-storage at Pusa will much facilitate this. Special attention will be devoted to acquiring a knowledge of Indian Termites (white-ants), the damage they do, and the best methods of preserving crops and constructional material from their ravages.

Publications.—A list of the more important of these is attached, but less and less time is available for work of this

nature as the energies of the staff become more fully occupied in other directions; and this is the more regrettable because a large amount of information relative to the life-histories of many economically important insects has been gathered during the last few years. Amongst the publications now in hand or proposed to be written, and for which a large amount of material is now ready, are practical manuals on lac culture and bee-keeping, Memoirs on life histories of *Orthoptera*, *Hymenoptera*, *Colleoptera*, *Lepidoptera* and *Rhynchota*, a Memoir on Termites, a revision of *Indian Insect Pests*, a revision of *Insects injurious to Indian Agriculture*, and separate manuals on insects injurious to Fruit-trees, Garden-crops and Grains, etc.

Eri Silk as a Cottage Industry. (Pamphlet in English, Urdu and Hindi.) December, 1910.

Mulberry Silk in the United Provinces. (Pamphlet in English, Urdu and Hindi.) December, 1910.

Commercial Possibilities of Eri Silk. C. C. Ghosh (Indian Industrial Conference). December, 1910.

List of Injurious Indian Insects. April, 1911.

List of Insects in Pusa Collection. December, 1910.

Life-histories of Aquatic Insects. D. Nowrojee. (Memoir in the press.)

Food of Birds in India. C. W. Mason. (Memoir in the press.)

Palm Beetles. C. C. Ghosh. (Memoir in the press.)

Life-history of *Croce flupennis*. C. C. Ghosh. (Bombay Journal.) October, 1910.

Hairy Caterpillars in South Arcot. Y. Ramachandra Rao. (Agri. Journal, July, 1910.)

Entomological Demonstration in Baroda. C. U. Patel. (Agri. Journal, October, 1910.)

Two Insect Pests of United Provinces. T. Bainbrigge Fletcher. (Agri. Journal, April, 1911.)

Four Reviews in Agricultural Journal and one in Bombay Natural History Society's Journal.

Insecticides. H. Maxwell-Lefroy. (Bulletin No. 23.) August, 1911.

Eri Silk. H. Maxwell-Lefroy and C. C. Ghosh. (Memoir in the press.)

The Moth-Borer (*Chilo simplex*) by T. Bainbrigge Fletcher. (Pamphlet in English.)

REPORT OF THE SECOND IMPERIAL ENTOMOLOGIST FOR THE YEAR 1910-11.

(F. M. HOWLETT, B.A.)

In 1909, after a year and nine months' service, I was absent on sick leave for a year and five months, returning to Pusa on March 22nd last. I have, therefore, now just completed two years of active service, and the present is a convenient opportunity for putting forward one or two conclusions regarding the work of my section.

I was appointed to study Diptera, and in particular those insects which suck blood and which may transmit disease.

Roughly speaking the study of any group of insects usually takes one or two distinct but complementary lines:—

(1) *Taxonomics*.—The study of the structure of dead specimens as a means of obtaining an accurate nomenclature and scheme of classification, thereby facilitating the correlation of results obtained by work in other branches.

(2) *Bionomics*.—The study of the life-history, from egg to adult, and the habits of living insects, their relations with other organisms and the factors which determine their various activities as a means of obtaining knowledge which will enable us to control these activities.

Of these, (1) can be undertaken in any country to which specimens can be sent, and at any place affording sufficient facilities in the way of necessary literature. In this country the Indian Museum is the only institution at present possessing a library with any pretensions to adequacy in respect of Dipterous taxonomics; (2) can be undertaken only on the spot. The elucidation of the life-history and reactions of insects is the only way whereby we can attain to more than an empirical knowledge of how to control them. To follow this line in the case of a group such as Diptera, about which so little is yet known, demands moreover a

somewhat broader scientific outlook than is necessary to the pure systematist.

It would of course be possible to pursue taxonomic studies and occupy ourselves with the description and naming of new species of Diptera, useful work which might well be extended over several years, but this would, in my view, constitute under the circumstances a misdirection of energy, since such work can be better and more easily done elsewhere.

On these and other grounds I have regarded (2) as the direction in which our work should proceed, and I have now a foundation in a knowledge of the main features in the life-history and habits of all groups of blood-sucking insects in India, as also of the few Diptera which are of any considerable direct agricultural importance. I make use advisedly of the phrase "main features," since the present arrangements regarding laboratory accommodation do not admit of insects being kept alive except under conditions so unsuitable as often to make it difficult or impossible to obtain reliable results from observation of individuals in captivity. Our disabilities in this direction are serious, but I am glad to say that steps are now being taken towards the provision of more suitable accommodation.

I returned from England in March, arriving at Bombay on the 10th and at Pusa on the 22nd. No touring has been undertaken since that date. I found that since my departure an amount of material has accumulated which has occupied a good deal of my attention and which will take time to arrange and work out. A portion of our *Nemocera* has been named by Mr. Brunetti at the Indian Museum, and the identifications of a number of the *Tabanidæ* sent to the British Museum in 1908 have now been published, which will facilitate work in this group.

I do not here attempt to submit a detailed report of the past four months. In addition to work on the collection and on blood-insects in general, attention has been directed in particular to (1) parasites of *Tabanidæ*, mainly observations

on an egg-parasite of our common hot weather *Tabanus* (*T. albimedijs*); (2) temperature reactions of Mosquitos; I believe I have found that temperature constitutes at least one of the main factors controlling mosquito-bite; more observations are required, and the work is still in progress; (3) the relative efficiency of "millions" and other enemies of mosquito-larvæ, in progress; (4) Peach-flies; with regard to these last it seems improbable that their attacks can be completely prevented by anything short of netting the trees, but we have now a cheap and simple method (depending on the "chemico-sexual" reactions of the male flies) whereby the damage they do may be very much reduced.

A number of publications are in hand. Four students have been received, though it was impossible to allot them any window-space in which to work.

While absent on sick leave, I attended the First International Congress of Entomology at Brussels, and though unable to enjoy the lavish hospitality which was displayed by the Congress Officials towards all visiting delegates, I was present at all the meetings and read two papers, by Mr. Lefroy and myself. These will be published in the Proceedings of the Congress. From the scientific point of view, the Congress was most successful, the great majority of the papers read being of a high standard of excellence, and I cannot overestimate the value of this opportunity of getting into touch with recent work, and of meeting and exchanging views with Entomologists of other countries.

In connection with a plague of house-flies near Norwich I carried out (in collaboration with Dr. Copeman, F.R.S., Medical Inspector to the Local Government Board, and Mr. Merriman) what I believe to be the first successful series of experiments on the range and rate of flight of these insects under natural conditions, a point of considerable importance with regard to disease-transmission. The results are published in "New Series No. 53 of the Local Government Board Reports on Public Health and Medical Subjects."

Prior to sailing for India I spent five weeks in Cambridge, working in Professor Nuttall's laboratory on the

respiratory mechanism of Ticks and the influence of temperature on rat-fleas; I may remark that the temperature which was fatal to adult fleas was found to be unexpectedly low. I also prepared several illustrations for Professor Nuttall, made an experimental study of the effects of various degrees of magnification and reduction in reproducing drawings and wrote two articles [on (1) Mosquitos and Temperature, (2) Methods of preserving Insects] which were published in "Parasitology."

Programme of work for 1911-12.—Work on blood-sucking insects, ticks, and other similar parasites directly or indirectly injurious to man will be continued, and attention will also be given to Dipterous pests of crops and fruit. Instruction will be given to agricultural students in these subjects.

A large amount of time will have to be given to working through and arranging the material which has accumulated during my absence, sent in by Medical and Veterinary Officers.

Special investigations proposed are :—

- (1) Life-history and habits of *Simulium* (hill cattle-fly), the dung-infesting Cattle-flies, Sand-flies, and such house-flies as are likely to be found acting as carriers of intestinal diseases.
- (2) Bionomics of Mosquitos, with special reference to the influence of temperature.
- (3) Influence of external conditions on the life-history of Fleas.
- (4) Reaction of Diptera to chemical stimuli.

REPORT OF THE IMPERIAL BACTERIOLOGIST
FOR THE YEAR 1910-11.

(C. M. HUTCHINSON, B.A.)

The work of the Bacteriological Section during the past year, the first during which it has been in operation, has necessarily been largely confined to trial and selection of the methods best adapted for dealing with the special conditions of soil and climate obtaining in India. The biological analysis of a soil not only involves a determination of the number and kinds of bacteria contained in it and their relation to the production of plant food, but must also include investigations having for their aim the discovery of how such bacterial functions as make for fertility may be encouraged and used to the best advantage in the ordinary operations of agricultural practice. Hence the main lines of work of this section have been aimed at determining under what conditions various soils will best serve as culture media for those bacteria, naturally present in them, upon which the processes of conversion of the organic nitrogen of humus into assimilable nitrates depend.

Much preliminary work has been done in testing methods already in use, and modifying them in accordance with the requirements of local conditions.

Special attention has been paid to methods of plating soils in such a way as to obtain information as to the number, kinds, and functions of the bacteria in them; this has involved a study of media suitable for the purpose, and of methods of inoculation, and this study is still in progress, as it appears probable that each soil requires variation in the composition of the medium in which it is to be plated, in accordance with its chemical and physical character, and with special regard to its previous agricultural history. In soil plates made for the purpose of counting the numbers of bacteria present per unit volume or unit weight,

special attention must be paid to the variations in soil climate previous to the time of sampling, as otherwise erroneous conclusions may be drawn as to the number of bacteria normally present. For instance, a rainfall of one-tenth of an inch in December has been found to raise the number of bacteria to 100 millions per gram in the course of 36 hours, whereas the same soil contained only 5 millions per gram two weeks later. Similarly the rate of decomposition and nitrification of organic matter in Indian soils appears to be very different from that which has been observed in Europe, and is no doubt to be correlated with the special conditions of soil and climate of this country. These cases have been referred to as illustrations of the necessity for proceeding with great caution in working out special problems by the application of generally accepted methods.

A complete series of experiments has been carried out to determine the best means of sterilizing soils, as the majority of experiments on soil bacteriology depend upon work with sterile soil as a medium. Great difficulty has been experienced in obtaining completely sterile soil; intermittent steaming in many cases has failed to ensure sterility, possibly owing to the rapid formation and germination of spores by some of the numerous spore formers present, and the use of the autoclave for pots of soil, of which only one can be inserted at a time, makes an experiment involving the use of some 50 pots almost impracticable, owing to the differences in time involved. A sterilizing plant for dealing with a large number of pots simultaneously is very much needed.

Samples of Pusa soils have been analysed bacteriologically, pure cultures of the bacteria found have been made, and their physiological functions examined. Special attention has been paid to their relative ammonifying power, and the knowledge thus obtained is now being utilized in dealing with special problems.

A special study has been made of the effect of hot weather ploughing upon the bacterial content of the soil and

its possible relation to the undoubted increase in fertility resulting therefrom. It has been found that this operation increases the rate of ammonification of the soil humus, probably by the selective action of combined desiccation and abnormal temperature; similar results can be obtained by heating the soil to 60° C., the soil plates shewing a survival of the more active ammonifiers such as *B. Mycoides* and *B. Subtilis*, whilst the highly aerated condition of the soil inhibits the activity of surviving anaerobic spore formers. The net result is an extremely rapid formation of ammonia, part of which is retained by the soil and nitrified or taken up directly by plants, and part is lost by diffusion; in this way rapid depletion of the soil nitrogen must take place, and subsequent fertility will depend upon the judicious use of green manures; the economic value of the method depends upon the power which it places in the hands of the agriculturist of rapidly converting green manure or other organic nitrogen into plant food, although this may be counterbalanced to some extent by loss of nitrogen as ammonia.

Study of Pusa soil taken from depths down to nine feet shows large numbers of bacteria even at this low level; nitrification has been found actively proceeding in the third foot from the surface, the greatest amount of this taking place in the second six inches. Owing to the open texture of this soil it is improbable that denitrification occurs to any appreciable extent, but the rapid rate of ammonification and the vigorous growth of soil bacteria no doubt interfere with the production of nitrates.

A method of quantitative estimation of the changes in soil due to bacterial action, by periodical analysis of the soil gases, has given much information as to the conditions favourable for nitrification in soils; it is hoped that this method will be invaluable in the future for dealing with such problems as arise out of soil irrigation and drainage, and the use of green manures.

In connection with the experiments upon soil sterilization as a laboratory method, investigations have been car-

ried out to determine the effect of various methods of partial or complete sterilization upon fertility; these investigations are still in progress and have yielded some results of great interest, such as the fact that the addition of Toluene to a soil already sterilized by heat increases its suitability as a medium for the growth of ammonifying bacteria and consequently its fertility; this renders it unnecessary to assume that such action is due to the suppression of phagocytes, although there is of course no reason why such removal should not contribute to the general effect in soils partially sterilized by addition of Toluene.

So far but little work has been done upon any but local soils, as these have afforded ample opportunity for research, but samples of *Usar* soil have been examined in connection with the use of gypsum, cattle manure, and straw as means of modifying their infertile condition. Dr. Leather kindly supplied samples of these soils, and also some black cotton, Shillong, Bangalore, and Akola soils, which have been used for purposes of comparison with Pusa soils.

A circular letter was addressed to Directors of Agriculture and Principals of Agricultural Colleges in the Provinces with a view to eliciting their opinions as to the scope for bacteriological work on soils, and the existence of special problems of local interest suitable for investigation by this section. The replies were of great interest as shewing the very general realization of the value of such work, and many useful suggestions as to lines of enquiry were received. The opinion was expressed in several quarters that the training of assistants as soil bacteriologists who would be capable of dealing with local problems in the Provinces, should be an important item in the work of this section at Pusa. This is a point of view with which I am in complete agreement and I wish to express my opinion that the work done during the past year has shown the necessity for training in the use of the special laboratory methods which are necessary in India, and that such assistants as may be selected for work on soil bacteriology in the provinces

should undergo a preliminary training at Pusa. It is important that these men should have a previous training in analytical chemistry of a high order, as my experience has been that it is possible to teach bacteriology to a chemist, but that the converse alternative is a waste of time. This was my own experience at Pusa with a medically-trained bacteriologist who acted for a time as my assistant, and whose qualifications as a biologist did not fit him for work as a soil bacteriologist, this being due to the very different nature of the work involved in medical and soil bacteriology. On the other hand my present three assistants who are all chemists, have shown great aptitude for bacteriological work, and their previous training as analysts has been invaluable in dealing with soil problems, which depend largely for their solution upon quantitative estimation of chemical changes in soil constituents.

Certain special problems have been dealt with during the year; these include investigations of the cause of:—

1. A bacterial disease of Tobacco occurring in Rangpur, due to the presence of a strain of *Bacillus Solanacearum*, differing from those described in America and Japan in its pathogenicity both for Tobacco and other Solanaceous plants, such as Tomato and Brinjal (*Solanum Melongena*).
2. A disease of the *Eri* silkworm associated with the presence of bacteria in the intestine; Memoirs on these two subjects are in hand. Invaluable assistance in the preparation of sections for microscopic examination in connection with these diseases was afforded by Mr. Shaw of the Mycological Section, who was kindly permitted by the Imperial Mycologist to devote a considerable amount of time to this work.
3. The efficacy of Ratin and Trope Ratin as rat exterminators in India. Experiments were made with fresh samples received from England, and a report on the results was furnished to the Inspector General of Agriculture in India.

Ratin is a bacterial culture prepared in Copenhagen, which is intended to produce an infectious disease in rats which have fed on baits treated with it, and which then spread the contagion amongst others. Although the cultures when received at Pusa were alive, as was proved by transfers, no pathogenic effects followed when given with food to captive rats. In corresponding with the Director of the Ratin Laboratory at Copenhagen I suggested that the virulence of the cultures might be regained by cultural methods in India.

Trope Ratin is not a bacterial culture but a vegetable poison, the principal feature of which is its toxicity for rats and mice and harmlessness for other animals. Experiments proved that its efficacy in India depends upon its use within a limited period of time after its preparation, as rapid deterioration takes place with loss of toxicity. Its cost precludes any possibility of use on a large scale by cultivators, but might allow of employment in special cases, such as in granaries or warehouses.

4. A disease of *Tussar* silkworms at Chaibassa was investigated and a report submitted to the Director of Agriculture in Bengal. The general conclusion arrived at was that death was due to bacterial invasion of the alimentary canal, but that as the extent to which this developed was dependent on unsuitable diet consequent principally on climatic causes, it would be impracticable to apply preventive or remedial measures.
5. A scheme for bacteriological work in connection with the proposed dairy at Pusa was elaborated, including the idea of a course of training for students in Bacteriology as applied to dairy work.

Programme of work for 1911-12.—1. The systematic investigation of the distribution, physiological character, and functions of soil bacteria in India will be continued.

2. A special line of enquiry will be taken up as to the relations existing between the practice of green manuring in India and the activities of soil bacteria.

3. Special problems, such as plant diseases of bacterial origin, will be dealt with as occasion may arise and opportunity permit.

4. The training of the assistants in the section will be continued.

Publication.—An article on the influence of Bacteria upon soil fertility was published in the Agricultural Journal of India, Vol. VI, Part II, April 1911.

REPORT OF THE IMPERIAL COTTON SPECIALIST
FOR THE YEAR 1910-11.

(G. A. GAMMIE, F.L.S.)

I held charge of the appointment from the 1st July to the 5th August 1910, when I proceeded on privilege leave. During my absence, Mr. S. V. Shevade, B.Sc., held current charge of my office. I resumed my duties on my return on the 6th November and continued in charge until the end of the year under report.

In July, Londa, Dharwar Experimental Station, Gokak Experimental Station and Vadgaon (all in the Bombay Presidency) were visited. In the months of August and September, Mr. Shevade visited Vadgaon, Dharwar, Gadag, Kilgiri and Kumbarganvi. After my return from leave, I visited Vadgaon and made a tour in the Central Provinces in the company of the respective Deputy Directors. Khandwa, Raipur, Nagpur and Akola were visited. In November, I also visited Dhulia and Ahmednagar. In December, I again went to Vadgaon in connection with a scheme to introduce cotton into this tract, and in January I visited Khanapur, Londa, Belgaum and Desur with the same object. In the same month I saw the cotton-experiments at Sholapur. In February, I completed my observations on cotton growing in the Deccan, at Takari and Islampur and joined the Deputy Director on tour in Gujarat, visiting Navsari, Surat and Nadiad. In March, I met the Deputy Director of Agriculture, Bengal, to advise him regarding the prospects of cotton cultivation at Chinsurah. I again visited the Experimental Stations in the Southern Mahratta Country. For the remainder of the period I was engaged in laying down a series of trials in my experimental station at Kirkee.

Central Provinces Cottons.

I visited the Experimental Station at Khandwa, where I met Mr. Evans, the Deputy Director of the Northern Division. This station is 13 acres in extent and is divided into $\frac{1}{2}$ acre plots, seven of which are devoted to cotton and five to *Jowar* and *Bajri* varieties. The experiments on cotton will be continued this year, taking in, however, only four varieties, *malvensis*, *roseum*, *Saugor Jari*, *Bhuri* and, perhaps, *Cambodia*. The following are the notes I drew out on the ground during my inspection:—

Karkeli.—This being *Hinganghat (Bani)* is not suited to this tract, and the fact is sufficiently proved by the appearance of the plot this season.

Malvensis is strong and vigorous and the outturn promises to be satisfactory. The staple, almost as harsh as, is longer than that of *roseum*. Which of the two will ultimately prove to be the most profitable is a point only to be determined by a test of outturn per acre. Local opinion strongly inclines to the belief that *roseum* is the more remunerative crop. This year *roseum*, being on a high-lying plot with shallow soil, cannot safely be compared for outturn with *malvensis*, which is on a lower level with deeper and richer soil.

Saugor Jari had borne its ripe bolls intact for about a month, and the White Flowered Varhadi or *roseum* also retained its ripe cotton uncommonly well. Practically none had yet fallen to the ground. The retention of the ripe cotton in the open bolls is a characteristic general to our indigenous Indian cottons.

Of *Bhuri* and *Cambodia* it can be safely said that the former is almost certain to succeed in the better classes of soil in this district. The group of cultivators, who accompanied us in the fields, concurred in my view after inspecting the crop as it stood on the ground.

Cambodia does not promise so well in the northern as in the southern cotton districts. However, to make the mat-

ter certain, it would be quite worth while to give it another year's chance.

Saugor Jari is a dwarf variety, coming so quickly to maturity that the first picking is ready this year in the middle of October. The seed was originally brought from the Rehli Taluka of the Saugor District. It is an extremely prolific cropper and appears to be suitable more especially for the poorer classes of soils, which are apt to lose moisture rapidly when the late monsoon fails as it often does in this district.

The seed obtained locally in Burhanpur has produced a crop so mixed (the mixture consisting of *Jari* with a smaller proportion of *Bani* and Upland Georgian) that the fact strengthens our conviction that, if pure varieties are established by the Department, which will then distribute them for general cultivation, methods must decidedly be devised, by home or village ginning or otherwise, to ensure that these varieties are maintained in their purity. As regards the establishment of this particular Experimental Station I foresee with satisfaction, that, being by its very nature a demonstration on an actual cultivator's land with the implements and labour supplied from his stock, the results will be readily visible to him and his neighbours.

In Berar and the Central Provinces, where cotton is usually grown associated with *Tur* (*Cajanus indicus*) more attention could be profitably paid to the cleanliness of the fields, which are infested with coarse grasses, *Celosia argentea* and other weeds.

I visited the Experimental Stations at Raipur, Nagpur and Akola in the company of Mr. Clouston, the Deputy Director, and Mr. Graham, the Economic Botanist.

At Raipur, which is beyond the cotton tracts, two plots were devoted to *Bhuri* and *Cambodia* cottons. The former gave a good crop last year and promised well for this. The Rajnandgaon Mill bought the produce at a fair price and the Manager is anxious to see the increased cultivation of this variety. It suffers from boll-worm, however, and the

general conditions of the district do not seem to be altogether favourable.

Cambodia looks unthrifty and chances are decidedly in its disfavour, but I advised Mr. Clouston to give it another trial as the rains have been abnormally heavy. Attempts to introduce the cultivation of *Deshi* cotton and *Jowar* have resulted in failure.

At Rajnandgaon we visited two fields of *Bhuri* in the company of Mr. Fredericson, the Manager of the local mill. These had done very well and the local cultivators were impressed with the result. Mr. Fredericson, however, says that *Bhuri* will not altogether serve as a substitute for American Upland, which is superior in quality. It will compete on favourable terms with the longer stapled indigenous varieties such as *Broach*, and this, after all, is a *desideratum* in the Central Provinces.

At Nagpur, Mr. Clouston still retains his plots sown from seeds locally obtained from many parts of the province and these have enabled him to gauge the nature and extent of the mixtures as they normally exist in the fields. Various high-class Uplands from American seed do not hold out promise of success. The utility of protecting cotton fields against insect attacks with girdles of *Bhendi* still seems to be a moot point, but, from my own experience, I cannot help considering that there is much to be said in its favour. Insects certainly prefer it to cotton, and if care be exercised in its destruction when its purpose is effected, much latent and active insect life must be destroyed at the same time.

The varieties of cotton actually under serious trial consist of *Bhuri*, *malvensis*, *vera*, *cutchica* and *rosea*.

In order of their value in length of staple they would stand thus :—(excluding *Bhuri*), *malvensis*, *vera*, *rosea* and *cutchica*. The last two are white-flowered forms of the two preceding them. *Malvensis* and *vera* (yellow-flowered forms) are decidedly superior in the matter of staple, but they are surpassed in percentage and total yield by *rosea* and *cutchica* (white-flowered forms). The valuations given

by the trade are practically equal for all, so, from a cultivator's point of view, the two last can safely be taken as the best to grow. Mr. Clouston estimates that he has gained from 2 to 3 per cent. in quantity by selection, and I seized the opportunity to point out to him that this is really a long step in advance, especially when it becomes established over the enormous cotton tracts of the Central Provinces and Berar.

The popular belief is that, by scientific methods, an increase in length of staple and proportion of cotton to seed can be easily attained, but the public generally and members of the Agricultural Department also should hold steadily in their view the fact that to evolve an addition of even one or two per cent. in length of staple and percentage of cotton to seed in a few years is in itself a notable feat. and that it is chimerical perhaps to hope to reach anything better. Anyhow, it would at least serve as an excellent foundation for a fresh start in advance.

Forms of all varieties with narrow-lobed leaves are more easily fixed than those with broad lobes. Undue importance should not, however, be attached to the degree of division in the leaves. At the Telinkheri farm there are plots of *Bhuri*, *Cambodia* and the indigenous varieties. All have suffered, although slightly so, from water-logging during the recent heavy rains. Cotton is a crop with a decided predilection for a well-drained soil.

The Department of these provinces is quite alive to the danger of the possibility of the reputation of their selected seed being ruined by the addition of local bazar seed by unscrupulous dealers for the sake of a temporary profit. It is difficult to conceive how such a contingency can be met in the case of indigenous varieties in which the seeds do not differ materially.

Cambodia, in all cases, seems to be inferior in strength and quality of produce to *Bhuri* in the Central Provinces and Berar, and it is also about three weeks longer in arriving at maturity, an objection of vital importance in these short season tracts.

At Akola, where a large area of the Experimental Station is devoted to the raising of selected seed, the cottons comprise *Bhuri*, *malvensis*, *vera*, *rosea*, *cutchica* and *Bani*. *Bani* has fallen into disrepute and one seed farm at Risod, especially devoted to producing its seed, has great difficulty in disposing of it. *Bhuri* seed is in rapidly increasing demand as are also *malvensis* and *rosea*, but the last-named, from its productiveness and hardiness, appeals most strongly to the cultivator. The manurial experiments appear so far to prove that farmyard manure has a distinct effect, but, that on account of their cost and trifling action there is little or practically no advantage gained from the use of artificial fertilizers. Farmyard manure and uric earth mixed give a better result than either applied alone.

All the varieties of cotton are pure now, and the chief difficulty ahead lies in the maintenance of this purity in the cultivator's fields. An accidental admixture of varieties on this station arose from the fact that whole seed was fed to the cattle and this often germinated in the manure when spread on the fields. Crushing the seed, of course, has removed this defect.

Experiments with English and indigenous ploughs and with the *Bhakar* go to prove that ploughing tends to assist water-logging in a wet season when the *Bhakar* is most effectual, but the latter method fails in a season of drought. As the cultivator can only guess what the season is going to be this conclusion is not obviously helpful. It appears to be advantageous to follow the local practice of sowing cotton in anticipation of the setting-in of the rains, and the converse applies to *Jowar*, which suffers badly if dry weather supervenes after germination.

In 1910, there were 3,000 acres of *Bhuri* under cultivation in Berar. Unfortunately the epidemic of plague greatly retarded its preparation for the market. The area actually under seed farm of all varieties is 600 acres. Three varieties of seed are supplied on purchase from this farm, namely, *malvensis*, *rosea* and *Bhuri*. At Risod in the

Hinganghat tract *Bani* is grown for distribution, but there is no call for the seed as the people are introducing the coarser, hardier and more productive *Jari* (vera) and *Varhadi* (rosea). An efficient hand gin of moderate cost and simple construction which would clean an appreciable amount of cotton per working day is an urgent necessity in the cotton tracts.

I wish here to emphasize my opinion that a real advance in the improvement of some of the staple cottons of the Central Provinces and Berar has already been effected. The cultivators show a practical appreciation of the fact by cheerfully paying enhanced rates for the selected seed supplied by the experimental stations. The chief difficulty in the future will be to maintain the varieties sufficiently pure. For some years to come the difficulty must either be met by large extensions of seed farms or by special arrangements with reliable cultivators either of villages collectively or as individual persons. At the same time steps should be taken to ensure that the cultivators receive fair rates for their improved produce.

It seems, however, too hopeful to look forward to the time when the people will realize the advantages of clean cultivation and cleanly methods of harvesting and marketing.

The British Cotton Growing Association sent the following gratifying account of the season's cottons grown at Akola :—

Value of Middling American 8-07d.

- No. 1. *Bhuri*.—"Fully good middling" in grade. Staple about 1 inch. Strong. Value 7-90*d.* to 8-00*d.*
- No. 2. *Bani*.—"Fully good middling" in grade. Staple about 1½ inch. Fine, but little soft. Value 8-40*d.*
- No. 3. *Malvensis*.—"Fully good middling" in grade, little stained. Staple 1 to 1½ inch, irregular and rather soft. Value 8-20*d.*

No. 4. *Roseum*.—"Fully good middling" in grade. Staple rough and extremely short. Value 7d., quite nominal.

It is mentioned that "with the exception of the fourth sample, *Roseum*, all the samples sent are useful cottons which could be readily sold in this market at considerably higher prices than are obtained from East Indian cotton, and we hope that there may be some possibility of these cottons being produced in quantity in your district."

Bombay Cottons.

Trial with Bhuri cotton at Kumbarganvi (12 miles from Dharwar).—In March 1909, while discussing cotton matters with the Deputy Director of Agriculture at Dharwar, I suggested the possibility of a successful introduction of *Bhuri* into the tract lying in the heavy rainfall zone where land was largely left uncultivated. Accordingly a plot of about 3 acres was taken up at Kumbarganvi. The soil is shaly, and is known in local Kanarese as *Masari*, *Bhurkati* or *Rerti* in Marathi and *Gorat* in Gujerati.

The average annual rainfall is 50 to 60 inches, falling heavily from June to the end of September and more lightly till the beginning of November.

Two ploughings and three harrowings were given but no manure. The seed (obtained in 1908 from Bengal) was sown by drill at the rate of 20 lbs. per acre on the 18th August 1909. Germination was excellent and the plants were thinned out to a foot apart in the rows, which were at 2 feet intervals. The plants were soon attacked by stem borers and caterpillars. The latter were removed by hand, a difficult operation as the creatures concealed themselves during the day. This attack lasted for four weeks. It was estimated that 50 per cent. of the crop was attacked but the sequel proved that the plants received no material injury. The first picking was started on the 15th January; this gave 14 lbs. 7 oz. of seed cotton; the second was on the 25th February and gave 72 lbs. of seed cotton, the third and

the fourth on the 18th March and 1st April respectively and gave 130 lbs. (per acre 216 lbs. 7 oz.). The percentage of lint 1st picking—33·25; 2nd—34·12; and the 3rd—34·37.

The valuations showed that the resulting clean cotton was of very poor quality, the report being that it was no better than Bengals. The first, second and third pickings were valued at Rs. 280, Rs. 275 and Rs. 260 per candy of 784 lbs. Broach cotton in the same day's market being Rs. 330, Surat Rs. 345, and Navasari Rs. 360. Under normal circumstances *Bhuri* in Bengal stands at least as high as Broach. The unfavourable result was, however, instructive in that it suggested experiments with this cotton in various soils to determine the actual influence of soil on the final product.

Kulthi is probably the best rotation for cotton in this soil as it is already the custom to grow it here, and the heavy rainfall forbids the idea of growing *Jowar*. *Kumpta* was tried on a small plot, but, as was naturally to be expected, it was a failure.

The Cambodia cotton plants suffered so badly from the attacks of caterpillars that only a very few plants survived. They remained stunted in growth and the situation was manifestly unsuitable to them.

These two varieties were also sown on black soil at Aravadgi, about 2 miles distant from Kumbarganvi. The crops on the whole were superior to those at Kumbarganvi, but they suffered from the same insect attacks and in addition became so badly infested with Aphides that they had to be treated with spraying of kerosine oil emulsion.

Cambodia and *Bhuri* produced at Vadgaon from the same seed in 1910 were reported on by Messrs. Tata Brothers as being equal to Superfine Wardha Good at Rs. 340 and Fine Hinganghat Good at Rs. 340 respectively. This further exemplifies the effect of the soil on the quality of cotton, and trials, suggested by these valuations, are being undertaken during the present year at additional centres in order that we may ascertain the precise effects on the cotton

plant and its ultimate product induced by diverse climates and soils.

Another report from Khanapur gives a valuation of *Bhuri* at Rs. 370 and Cambodia at Rs. 340.

The 1910 crop of *Bhuri* at Kumbarganvi was valued at Rs. 380, Fine Surats of the same day being Rs. 380.

In the light of the second year's valuation it is difficult to understand why the first year's crop at Kumbarganvi should have been so inferior.

The Professor of Agriculture, Poona, kindly allowed me the use of a plot of land at Lonavla (where the average rainfall is 186.56 inches) to test the behaviour of *Bhuri*, Cambodia and *Kil* under a very heavy rainfall. The last-named, in its own home in the Garo Hills, luxuriates in almost quite as heavy a rainfall. Seeds of the three varieties were sown on the 19th June, Cambodia germinated well, but *Kil* and *Bhuri* only indifferently. The heavy rains and cold winds prevented further growth in the two latter and they died. Cambodia held out till about the end of July and finally succumbed in the heavy rain of August. It was a foregone conclusion perhaps that no cotton will withstand such heavy and continuous rainfall, but still it is satisfactory to obtain tangible proof of the fact.

Bourbon Cotton Cultivation on the Western Coast.—

In former years it was demonstrated to their own satisfaction by a few enthusiasts (who probably owed their success to watchful care), that Bourbon cotton could be profitably grown in the Konkan, and sporadic plants are certainly persistent and quite common in villages. To arouse fresh interest in the subject I persuaded some Mamlatdars to induce land-owning friends to make experiments and I supplied the necessary seed. The final reports, however, proved disappointing as, owing to heavy rains, not one trial resulted in success. Now that a Divisional Inspector has been appointed for the Konkan I hope that, under his supervision, further trials with Comilla cotton, a plant from a heavy rainfall area, may show some measure of success.

Cotton Crop Experiments conducted on the Dry Farm Experimental Station of Ahmednagar.—Here we have adverse conditions under another aspect, namely, of drought and not excessive rainfall. The season on the whole was reported to be good, but the rainfall was above the average and towards the end of the season was also untimely. The germination of the seeds was therefore affected by the packing of the soil which occurs during heavy falls of rain. The subsequent resowing of the numerous gaps and more than usually rapid growth of weeds threw an excessive addition to the normal cost of cultivation. The first picking when approaching maturity was destroyed by the heavy down-pour in the *Swati* rains. The plants, however, recovered, but the occurrence of a sudden frost finally destroyed the crop. *Karkeli* on the whole proved most resistant, yielding at the rate of 144 lbs. of seed cotton per acre, while 5 types of Khandesh cotton gave 94, 100, 104, 112, 114 lbs. respectively. Although due attention was paid to all the details of treatment and cultivation, no workable precautions could possibly be employed to insure the crops against the vicissitudes of such an abnormal season.

The following are valuations by Messrs. Tata Sons on samples from Ahmednagar :—

No.	Name of cotton.	Remark.	Valuation.
			Rs.
1	Karkeli . . .	Equal to F. Barsi Gd., which class is very rare or non-existent. Soft in feel and of good staple.	330
2	N. V. M. type . .	Same as above, but slightly better in staple.	335
3	N. V. K. type . .	Same as No. 1, but slightly inferior in staple.	325
4	N. V. type . . .	Same as N. V. K.	325
5	N. R. C. type . .	Rather rough and very short in staple ; more like Khandesh.	305
6	Khandesh . . .	This is a superior quality of Khandesh cotton, superfine in colour. The district rarely, if ever, produces such cotton.	315

Brsgs.—Khandesh Gd, Rs. 310 per candy of 784 lbs.

Cotton Crop Experiments on the Dhulia Experimental Station.—I visited this station on the 29th November.

The first plot of cotton inspected was labelled N. R., a selection of *Neglectum roseum* out of the types ordinarily grown in the fields. The plants were robust, the stand even and the production excellent. The staple is that of *Varhadi*. Last year the produce of this was above 900 lbs. of seed cotton per acre with a percentage of 37.5. The seed cotton is bought by the merchants at the rate of Rs. 21-8-0 per maund (144 lbs.) against the rate of Rs. 20-8-0 per local cotton.

The second plot was of N. R. C. (*Neglectum roseum cutchicum*). This is also a selection from the local cotton. The crop produced last year was 850 lbs., percentage 35. The staple is a little longer and finer than that of N. R. and the cotton was valued at Rs. 10 more per candy (784 lbs.).

The third plot was that of *malensis*, N. V. M.; differs from *vera* proper or *Jari* in the superiority of its staple. It has been grown on a large scale only this year.

Comilla Cotton.—Fresh seed was imported this year from Hill Tipperah as the acclimatized plant had deteriorated. The lobes of the leaves are broad as well as narrow and the flowers are usually white, but some are yellow. The crop is very poor and very late.

Bhuri.—This plot looks good and productive. One cultivator at Amalner is said to have 20 acres of good *Bhuri* under cultivation. There is a rising demand for its seed and the prospects of success in Khandesh as in Berar are decidedly hopeful at present.

Cambodia looks more sturdy than *Bhuri* but it is a later crop. The prospects of both are of course uncertain until they have been subjected to the experience of a dry season. The cultivator at Amalner, already mentioned, has obtained from the merchants Rs. 10 per maund (144 lbs.) of seed cotton over the price of local cotton.

Of the crosses, that of *Comilla* with *Buni* is most promising as regards both quantity and quality. The selected

plants yield a staple over $\frac{3}{4}$ inch and ginning percentage of about 33.

Karkeli is not very promising, but still it yields a profit quite equal to that of the local crop.

Bani from Akola looks well, but it will never be a favourite crop in a tract where the cultivators prize the qualities of hardness and high percentage of cotton.

Neglectum var. *kathiawarensis*.—The growth is very vigorous and prolific. Last year it yielded 741 lbs. of seed cotton per acre, with a percentage of 27·10.

The following are some of the results obtained on the station :—

Name	Seed cotton per acre.	Percentage.
<i>Neglectum</i> var. <i>malvensis</i> . . .	686	26·10
„ „ <i>vera</i> . . .	729	30·00
„ „ <i>eutchica</i> . . .	780	35·50
„ „ <i>rosea</i> . . .	870	37·50

Inter se crossing in *Bhuri* and Cambodia has produced enormously strong plants.

As in the Central Provinces and Berar so also in Khandesh the same difficulty in the distribution and maintenance of the pure varieties has to be surmounted. So far there is only one demonstration plot, *viz.*, at Amalner, where the different types are grown. There is also a demonstration held at the Experimental Station every October and this had the desired effect of introducing the improved varieties to the attention of the cultivators who send in orders for seeds. In the local practice, seeds are sown through two tubes placed behind and dragged after the *bhakar*. This requires the attention of three people while the Gujerat drill (which is being introduced) only requires two. The Gujerat bullock hoe is also said to be more effective, as it brings the earth better round the plants.

The Manager of Messrs. Volkart's Spinning and Pressing Factory informed me that he was buying extensively pure supplies of the very coarse *Varadi* (*roseum*) cotton which he considers does really possess a staple. He says that this cotton is mostly used in Germany, Austria and Hungary and that *Bengals* are used in Italy. Fraudulent practices are obviously carried on by cultivators. Wet and damaged cotton is packed into the centre of finer stuff and much leaf and dirt is present. The dry, brown leaf is not so objectionable because it can be blown away, but it is difficult to free the cotton from the black leaf caused by damp.

Khandesh cotton seed bears a good reputation in the European market, its refraction being only 6 per cent. while that from Berar is $6\frac{1}{2}$ to 7.

The cultivators, as a rule, do not take away the seed during the ginning season, but just before sowing time, when they have made up their minds as to what they are to grow, they take whatever they can get in the shape of seed from the mounds in the compounds of the ginning factories. A few of the more careful cultivators, however, especially those who farm on a large scale, bring their seed cotton to the ginning factory, see it ginned in their presence, and often sell it during the process to the highest bidder. They take away there and then what they require for the next season's sowing.

Cotton Experiments at Sholapur.—I visited these in January in company with Mr. Patil, the Divisional Inspector of Agriculture. The first plots seen were at Mohanmala on land owned by the late Rao Bahadur Warad. These experiments were started last year with the object of ascertaining the mixture existing in the cotton fields of the Sholapur District and also the value of the component parts of such mixtures.

The seeds were collected from all the talukas of the district. Mr. Patil has separated out these types and furnished the following analysis :—

A statement showing the Analysis of Cottons in the Sholapur District, 1910-11.

VEGETUMS.

Plot No.	Name of village from which the seed was obtained.	Name of Taluka.	Total No. of plants in each plot.	White flowered broad lobed.	Yellow flowered broad lobed.	White flowered narrow lobed.	Yellow flowered narrow lobed.	Branch.	Upland Georgian.	REMARKS.
1	Peha	Pandharpur . .	166	6	63.25	1.8	17.46	6	16.26	
2	Jour	Karnaba . . .	123	0	23.57	.81	10.56	63.4	4.06	
3	Tadola	Barsi	93	0	69.9	6.45	13.9	4.36	5.37	
4	Ponalwadi . . .	Karnaba . . .	74	0	45.5	1.3	10.8	40.5	6.7	
5	Tembhurni . . .	Ditto	49	0	50.18	2.03	14.3	18.3	6.1	
6	Malshiras . . .	Malshiras . . .	75	0	76.0	4.0	14.6	40	1.3	
7	Akluj	Ditto	88	0	58.0	3.4	6.8	25.0	6.8	
8	Vairag	Barsi	51	0	80.4	0	9.8	5.88	3.92	
9	Sangola	Sangola	36	0	55.5	0	19.44	2.8	22.2	
10	Bhatani	Pandharpur . .	83	1.2	56.6	0	20.4	14.4	7.2	

I understand from Mr. Patil that the experiments are to be transferred to Karmala, about 12 miles from Jeur Station. The villagers there have lost their crops through the use of unsuitable seed obtained locally from ginning mills. The cotton usually grown by them is a mixture of neglectum with a little Jowari Hatti and Upland. The people prefer the narrow-lobed neglectum and say that they are willing to buy up any quantity of seed. The rainfall is said to be precarious and the methods of cultivation poor so that the locality seems altogether unsuitable for high class cottons. I have recommended that pure varieties of neglectum be obtained either from Dhulia or from Akola. We have since sent 1,300 lbs. of Varhadi seed to Mr. Patil, also 150 lbs. of Saugor-Jari seed, an early ripening dwarf, prolific variety, which ripens its crop at least three weeks in advance of Jari and Varhadi: I also visited Pasare's Estate on which the Department is working with manurial experiments.

The following are valuations by Messrs. Tata Sons on samples sent from each of the treated plots:—

No.	Description of sample.	Report.	Price per	REMARKS.
			candy.	
1	Plot manured with F. Y. manure.	Strong in fibre and of good staple and has the appearance of the usual cotton of the Sholapur District.	Rs. 335	Western style.
2	Plot manured with pot-sulphate and superphosphate.	Weaker in staple than No. 1.	325	Ditto.
3	Plot manured with ammonia sulphate and superphosphate.	Staple and strength of fibres between Nos. 1 and 2.	330	Ditto.
4	Manured with superphosphate.	Equal to No. 1.	335	Ditto.
5	Manured with ammonia sulphate only.	Equal to No. 3.	330	Ditto.
6	Check plot; no manure.	Equal to No. 1.	335	Ditto.
7	Manured with pot-sulphate only.	This is the best of the whole group in colour, length of staple and strength of fibre.	340	Ditto.
8	No manure; check plot.	Equal to No. 1.	335	Ditto.
9	Manured with ammonia sulphate, superphosphate and pot-sulphate.	Equal to No. 2.	325	Ditto.
10	No label.	Equal to No. 1.	335	Ditto.

Basia.—Good Western Gd., Rs. 335.

.. Fine Branch Gd., Rs. 360.

Again, in company with Mr. Patil, I visited the experiments with Broach cotton (seeds imported from Navasari last year) near Islampur in the Krishna Valley. This is a highly cultivated and fertile tract and agricultural operations have been very carefully attended to.

In the first field local Jowari Hatti and the imported Broach are growing side by side. The former was ripening, while the latter bore only flowers and unripe bolls.

In another field of imported Broach, sown in June, the bolls were ripening. From the conditions of these two trials one sown in the end of July and the other in June, it is plainly obvious that no delay should occur in the sowing of Broach cotton in this district. I also suggested the trial of *Bhuri* and Cambodia in this tract.

The following are valuations of local Jowari Hatti and Broach cotton grown in adjacent plots on these trials :—

No.	Report.	Price per candy.	REMARKS.
1	If the seed is Bengal, it has certainly improved in soil and looks more like Miraj cotton.	Rs. 335	Western style.
2	Same remark as above ; it is better in colour than No. 1	340	Ditto.
3	Shows deterioration in colour only	390	Surat style.
4	Better than No. 3 in colour, but slightly shorter in staple .	385	Ditto.

N.B.—Nos. 1 and 2 are Jowari Hatti; Nos. 3 and 4 are from seed imported from Navasari.

Basis of valuation per candy :—

Fine Surat Gd., Rs. 380.

" Broach Gd., Rs. 360.

Good Western Gd., Rs. 335.

(Candy of 7·4 lbs.)

Some experiments are being conducted at Nadiad in the Kaira District to solve the very difficult problem of finding a better cotton than the local Rosi.

Three varieties are at present under trial; Bourbon, *Bhuri* and Cambodia :—

Bourbon.—This was the second year of its growth. During the first year it yielded 400 lbs. of seed cotton per acre, second year, 1,000 lbs. of seed

cotton per acre. The second year's growth was extremely satisfactory, so much so that the branches had intermixed and it was impossible to go into the field. It remained to be seen whether after pruning (third year) the outturn is maintained.

Bhuri.—This was sown in May under irrigation only until the rains broke; outturn 1,100 lbs. of seed cotton per acre.

Cambodia.—Sown in May under irrigation like *Bhuri*; outturn 800 lbs. of seed cotton per acre.

It seems that both *Bhuri* and *Cambodia* should be established before the rains to reap a good harvest. It was gathered that cultivators from the neighbourhood occasionally visited the farm and were satisfied with the growth, outturn, etc., and as a consequence of this the Superintendent has received many requisitions for the supply of seed of all the three varieties mentioned above.

Samples were valued by Messrs. Tata, Sons & Co. as follows :—

	Rs.	
Fine Surat	380	} per candy of 784 lbs.
Navasari	400	
Fine Broach	360	

Valuation of Nadiad Samples—

Bourbon.—Equal to F. Navasari Gd., good in colour and staple, Rs. 400.

Cambodia.—Equal to F. Broach Gd., but better in staple, Rs. 365.

Bhuri.—Equal to F. Broach Gd., Rs. 360.

From these valuations it will be seen that there is a strong possibility of at least three high class cottons being introduced profitably into Northern Gujerat.

Full reports of the cotton operations on the Bombay Experimental Stations will be found in the Progress Reports. Mr. Keatinge, the Director of Agriculture, in a recent note has clearly shown the present condition and prospects of cotton cultivation in the Bombay Presidency. This is entitled "Note on Improved and Exotic Cottons in the Bombay Presidency." It should be carefully studied by all who are interested in the improvement of Indian cottons.

Madras Cottons.

Good work is being done in the Southern Districts of the Presidency judging from the samples of selected cottons which were sent to me for valuation.

These were adjudged by the Directors of the Bombay Cotton Association, Limited, who remarked that all the samples showed nice clean cotton and the differences in price is all practically due to staple. That the Karunganni samples are *more* suitable for weaving mills than the Uppam samples, but both styles should suit buyers for export and local consumption.

The following is their detailed report:—

Samples of cotton from Madras submitted by the Imperial Cotton Specialist:—

	Rs.
Basis—Fine M. G. Broach	350
„ Fine M. G. Navasari	375
„ Fine G. F. Tinnevely	345

Serial No.	Description.	Approximate market value in Rs. per candy of 784 lbs. less 5½ per cent. discount.	REMARKS.
	<i>Uppam Variety.</i>		
1 U	Ordinary field crop	335	Rather harsh in staple; very clean.
2 U	Pedigree Uppam	340	Staple rather better than No. 1.
3 U	Ditto	340	Ditto.
4 U	Ditto	335	Ditto.
5 U	Ditto	335	Ditto.
6 U	Ditto	345	Ditto.
7 U	Ditto	340	Ditto.

Serial No.	Description.	Approximate market value in Rs. per candy of 784 lbs. less $5\frac{1}{2}$ per cent. discount.	REMARKS.
	<i>Karunganni Variety.</i>		
1 K	Karunganni ordinary field crop	345	Silky staple.
2 K	Pedigree Karunganni	345	Ditto.
3 K	Ditto	345	Ditto.
4 K	Selected Karunganni	345	Ditto.
5 K	Ditto	343	Ditto.
6 K	Pedigree Karunganni	350	Ditto.
7 K	Ditto	345	Irregular in staple.
8 K	Ditto	345	Staple rather irregular.
9 K	Ditto	350	Staple good and silky.
10 K	Ditto	340	Ditto.
11 K	Ditto	345	Ditto.
12 K	Ditto	370	Long silky staple, excellent, spinning cotton.
12 K	Ditto	370	Ditto.
14 K	Ditto	375	Ditto.
15 K	Ditto	380	Ditto.

It will be seen from the above that the selections have been valued almost in their correct order by Mr. Sampson.

Bengal Cottons.

I visited the Experimental Station at Chinsurah and furnished the following report, which was based on an inspection and discussion with Mr. Smith, Deputy Director of Agriculture.

The first plots seen were of Cambodia and Bhuri cottons, one-fifth of an acre each. These were on well-drained raised land and their condition was very satisfactory indeed. As explained to me, I gathered that this class of land is very rare in the province, its height above the general level being due to an accumulation of silt and weeds thrown up while excavating tanks. It is the most suitable of soils for plantains, etc., and we can scarcely expect a cotton crop to compete with these in value. The second series of plots visited were of the same cottons on paddy land, lying at the general level. The plants were unthrifty and showed distinct signs of damage by water-logging earlier in the sea-

son. Practically no crop had been produced and the immature bolls were shrivelling. The plots of indigenous varieties were only just coming into flower. This means that bolls could only be ripened during the hot weather, and as their produce at the best would only be equal to the most inferior Berar or Khandesh cotton, they are scarcely worth troubling with in a tract which grows more highly remunerative crops, such as rice and jute. *Deshila* and *Bhogila* are still later and the length of time they occupy the ground is a serious objection to their cultivation. It is to be regretted that the primitive people of Chutia Nagpur cannot be induced to extend the cultivation of Bhuri cotton in their country, but, so far as they are concerned, there is probably no material incentive for them to so exert themselves.

All the Indian varieties of cotton have now been tried in the deltaic area of Bengal, and the inevitable conclusion to be drawn from the experience thus earned is that the conditions of soil and climate are not in any way suitable for cotton cultivation, and I cannot recommend that experiments with a view to introduce their culture should be persevered with.

The following samples from Chinsurah, Bengal, were kindly reported on for me by Messrs. Tata, Sons & Co. of Bombay :—

No.	Name.	Report.	Price per candy.	REMARKS.
1	Cambodia	The cotton has preserved its silkiness and staple, but has deteriorated in class. It is F. G. in class.	Rs. 300	Bengal style.
2	Bhuri	Better than No. 1	310	Ditto.
3	Deshila	Very much deteriorated, and is like G. Bengal.	275	Ditto.
4	Bhogila	Deteriorated and can be likened to F. G. Bengal.	285	Ditto.

Basis per candy of 78½ lbs. —
F. Bengal, Rs. 315.

It will thus be seen that no very remunerative cotton has as yet been established in Bengal.

Punjab Cottons.

Excellent results are being attained by Mr. Milne, the Economic Botanist,* as will be seen from the account published in his progress report and by the British Cotton Growing Association, Manchester. It was considered that 161 A. F. was the best, while Pride of Georgia coming second is nearly equal by 199 F., 220 F., and King's Cotton is slightly lower than the last three. The reports on the indigenous cottons are not so favourable. It is to be hoped that the extension in the cultivation of the higher class cottons in the Punjab will be persevered with.

Valuations.—All samples received were submitted to Messrs. Tata, Sons & Co., Bombay, for valuation. Cordial acknowledgment is due to these gentlemen for their kindness and promptitude in giving opinions on cottons whenever submitted to them.

Some samples were also submitted to the Bombay Chamber of Commerce, to whom thanks are also due.

Programme of work for 1911-12.—1. To visit and advise on points regarding cotton and its cultivation whenever requested to do so by Provincial Departments of Agriculture.

2. By special invitation of the Department of Agriculture, Punjab, to report on the work done in the way of cotton improvement in that province. The question of the distribution of seeds of improved varieties will be further discussed with the proper authorities in the Central Provinces and Bombay Presidency.

3. The study of the behaviour of Bourbon, *Bhuri*, and such other cottons in non-cotton producing tracts as detailed in my last year's programme will be continued.

4. The conditions of cotton cultivation in Kathiawar and adjacent parts would be investigated.

5. An enquiry will be commenced on the manurial requirements of cotton.

PUBLICATIONS.

Article on Caravonica Cotton. Agricultural Journal of India,
Vol. V, Part III.

The present position and prospects of Cotton Cultivation in
India. For the International Congress of Tropical Agri-
culture, Brussels, May, 1910.

